AUTOMOBILE ENGINEER

DESIGN · PRODUCTION · MATERIALS

Vol. 51 No. 3 MARCH 1961 PRICE: 3s. 6d.

Among the most prized possessions
of resourceful engineers—**QUALCUT TOOLS**

QUALCUT TOOLS LIMITED, HANDSWORTH RD., SHEFFIELD 13. TEL: SHEFFIELD 49371/6

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The Austin A95 driven by Mr. L. W. Wheeler of Aldenham and owned by his employers Messrs. Biggs, Wall & Co. Ltd. During its 152,308 miles only BP 'Visco-static' oil has been used.

Mr. J. R. Kinsey, formerly Chief Engineer of the Automobile Association, measuring wear on the crankshaft of the A95 engine.

Business motorist does 152,308 miles on BP 'Visco-static' without even a de-coke

INDEPENDENT ENGINEER REPORTS REMARKABLY LITTLE WEAR

MR. L. W. WHEELER of Aldenham, Herts, does a big mileage. But never before has he done so many miles in one car, as in the Austin A95. This has completed 152,308 miles since new without any attention other than servicing. He has simply used BP Energol 'Visco-static' motor oil in the engine since it was new.

Mr. Wheeler was so impressed with this outstanding performance that he submitted the car for examination by an independent engineer, Mr. J. R. Kinsey, M.I.Mech.E. of A. Warren-Lambert & Co.

Under his supervision the engine was dismantled and all wearing surfaces were accurately checked. He reports that the engine showed a remarkably small amount of wear generally for such a huge mileage and a notable absence of scoring or bearing "pick-up". This is impressive proof of high efficiency lubrication with BP Energol 'Visco-static'.

Indeed it is safe to say that with new piston rings and bearing shells in one connecting rod and de-carbonising and re-seating valves the engine could go on to give many more thousands of miles of satisfactory service.

Why BP 'Visco-static' saves wear. Most wear in any engine occurs when warming up from cold. BP Energol 'Visco-static' prevents this in two ways. It guards against overnight corrosion. And, because it flows freely even in freezing cold, allows immediate oil circulation when the engine starts.

Tests with the radio-active wear detector have proved amazingly low wear with BP Energol 'Visco-static'.

Easier starting, saving in petrol too. With BP 'Visco-static' your engine turns over more freely, gives easier starting even in freezing cold. Because there is less oil drag you save on petrol too. And BP Energol 'Visco-static' is for all the year round use both winter and summer.

How to change. Be sure to have your engine drained and refilled with BP 'Visco-static' if you want to enjoy the maximum benefits from this advanced oil. *Ask at your BP garage for a copy of the report on Mr. Wheeler's car.*

BP

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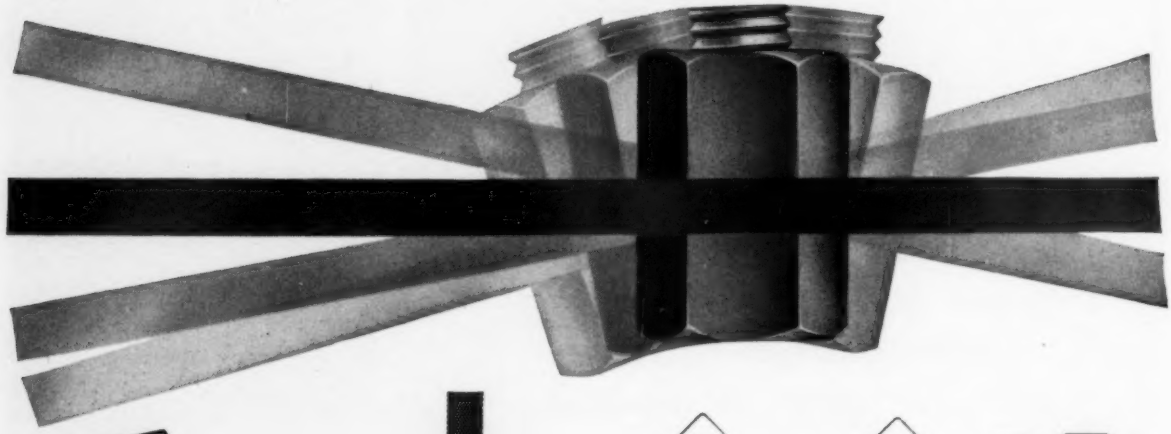
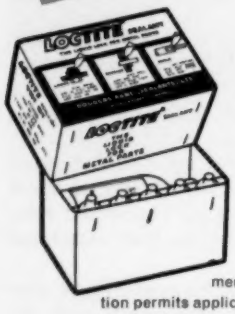
The Sensational Liquid Lock for Metal Parts

LOCTITE SEALANT supersedes all conventional methods of locking nuts, bolts, studs, set screws, adjusting screws—anything which may vibrate loose. It dispenses with lock nuts and other mechanical locking devices and methods—with outstanding cost savings. **LOCTITE SEALANT**, the new liquid plastic, penetrates between threads or closely fitting metal parts and hardens automatically inside the joint to give a permanent lock and seal to the joint, superior to any mechanical locking devices. LOCTITE treated parts can *NEVER* work loose, yet can be removed with ordinary tools.





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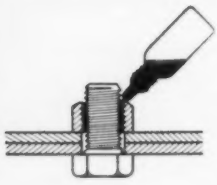
contains five grades of Loctite for experimental work. Grade selection permits application of predetermined locking torque on any size fastener.

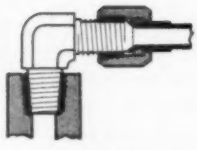


LOCKS

Makes any threaded part self-locking
★ prevents breakdowns caused by loose bolts, nuts, studs and screws

RETAINS

Makes bearing replacement easy
★ retains bearings without press fit
★ eliminates reboring, sleeves, shims, and weld metal build-up



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Prevents leaks in high-pressure fluid lines
★ completely fills joints with tough plastic
★ resists heat, cold, fuels, oil, water, solvents, all hydraulic fluids
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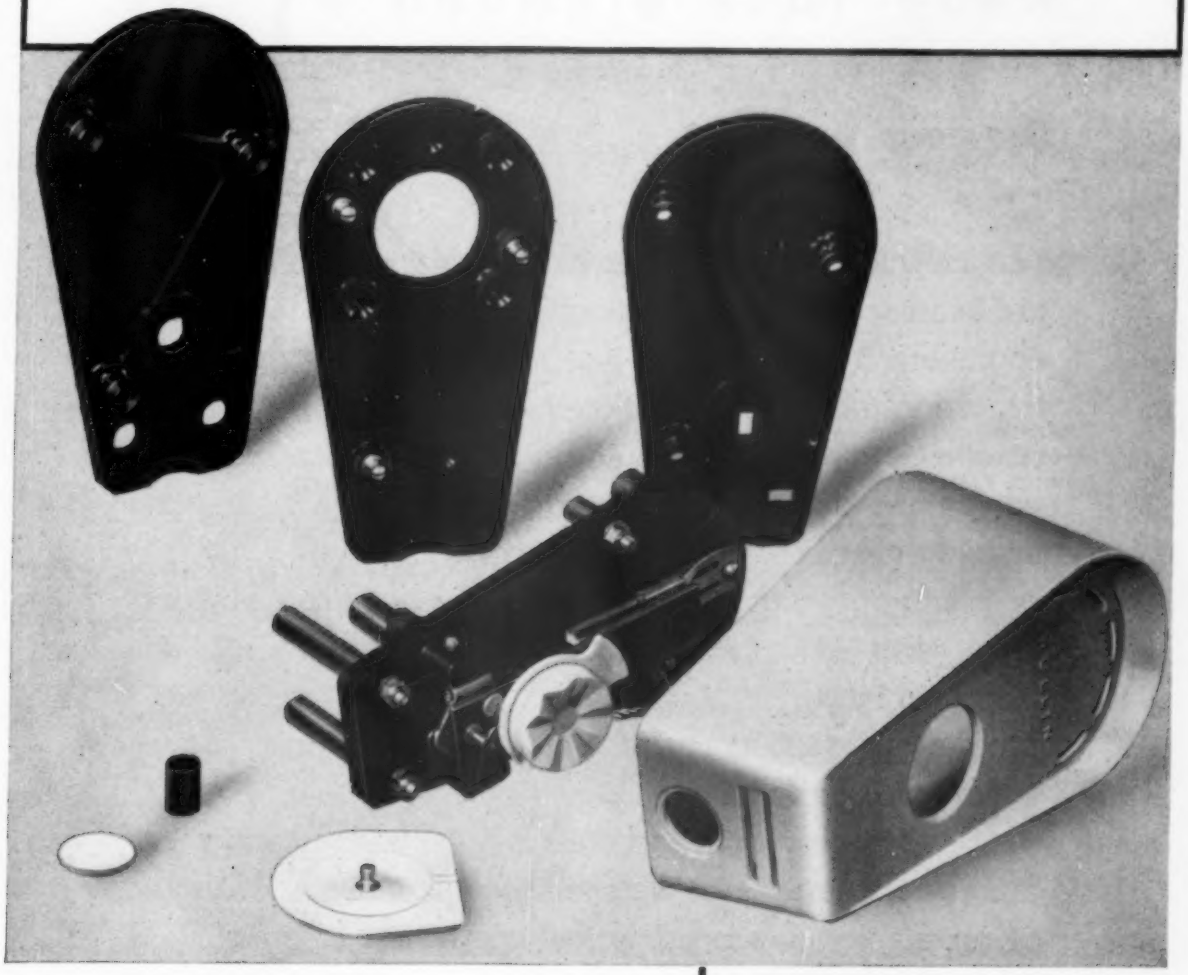

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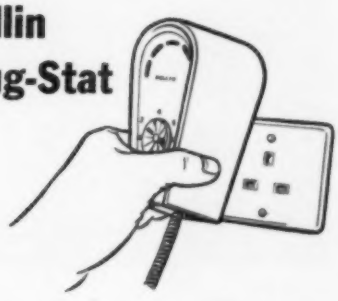
The Pullin Plug-Stat



the plug with the built-in thermostat, is playing an important part in cutting electricity costs. The components of the Plug-Stat represent the type of specialised work in which Metropolitan Plastics are unsurpassed.

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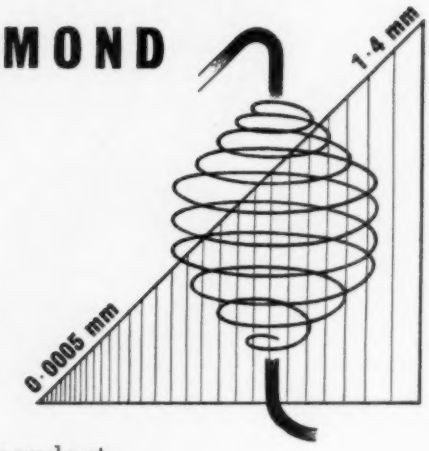
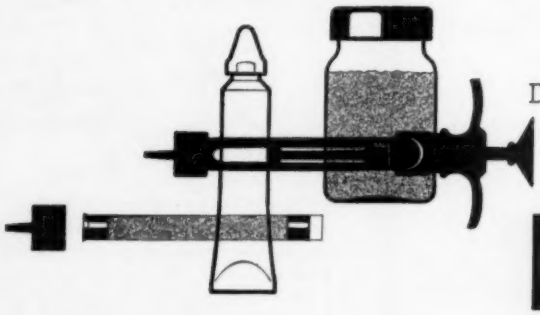


Diamond powder

Tools with shaped diamond tips are familiar to most production engineers. It sounds rather a tall order, though, to shape the hardest substance known. So it would be without diamond powder. From it are made the grinding wheels for the initial forming, and the lapping medium for the polishing operations. Without it, many other tasks would likewise be virtually impossible. The accurate manufacture of optical lenses, for example, or the preparation of hard metals, such as tungsten carbide, for dies or tool tips. Other important uses of diamond powder are in the production of diamond dies, used in wire drawing, and jewel bearings for watches and instruments. And much of our present-day metallurgical knowledge is gained from diamond-polished specimens for metallographic examination. We make the powder in 32 grades—particle sizes range from about 1.4 mm down to 0.0005 mm!



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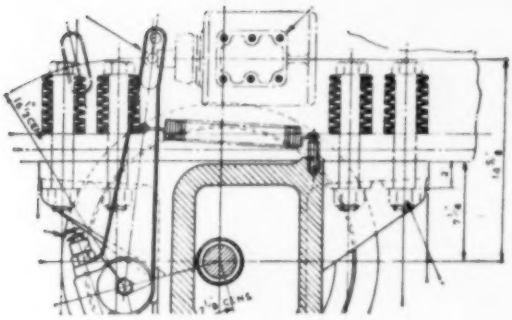

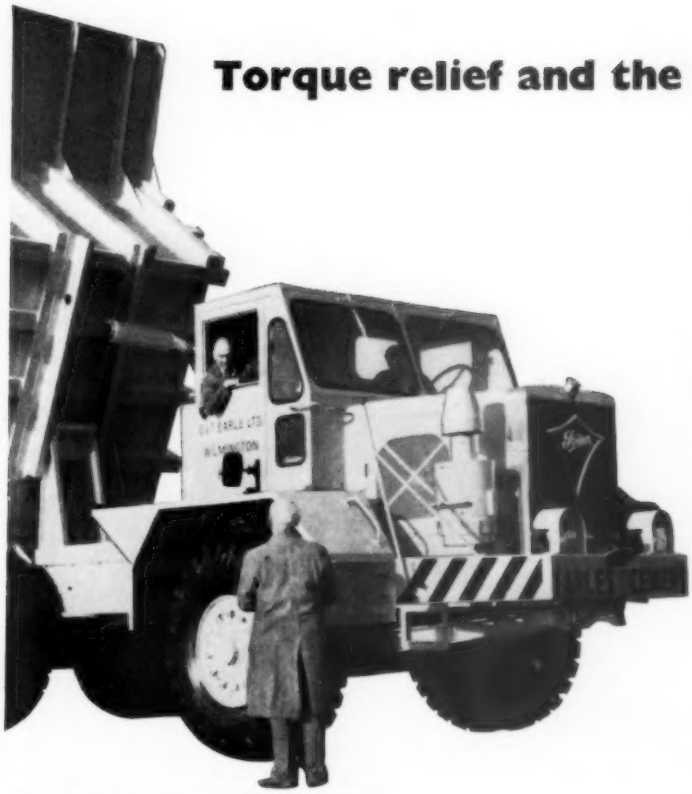

Torque relief and the Belleville Washer

Messrs. Fodens Ltd., fit Belleville washers in packs of 7 pairs on their F.R.6/45 Heavy Duty Dumper. This proved to be the most effective method of relieving twisting of the rear axle case produced by braking and transmission torques.

The potential uses of Belleville washers are endless.

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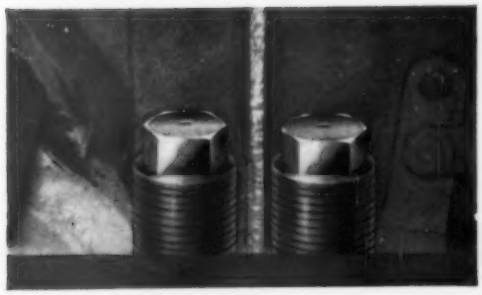

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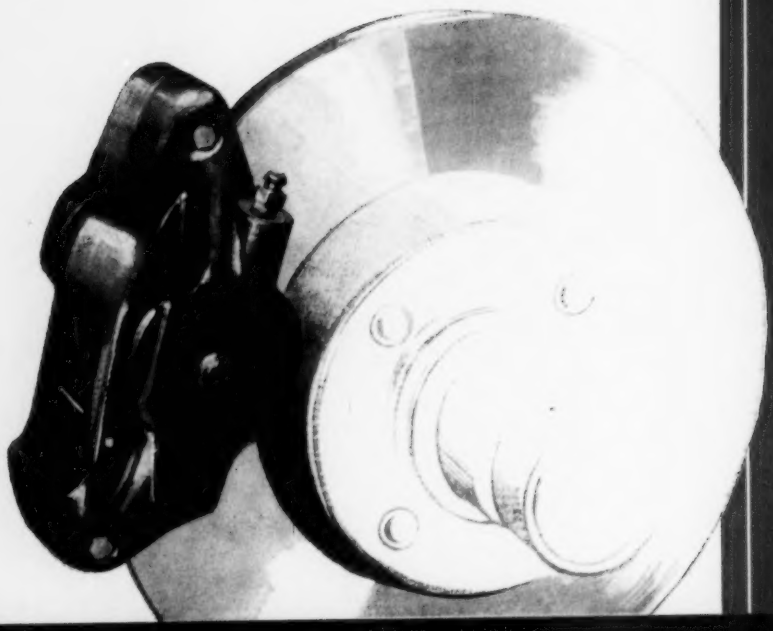

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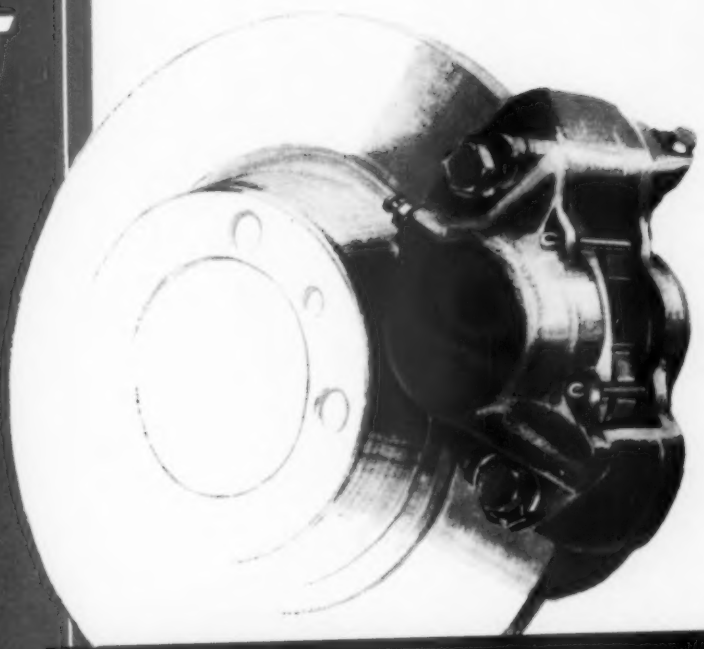

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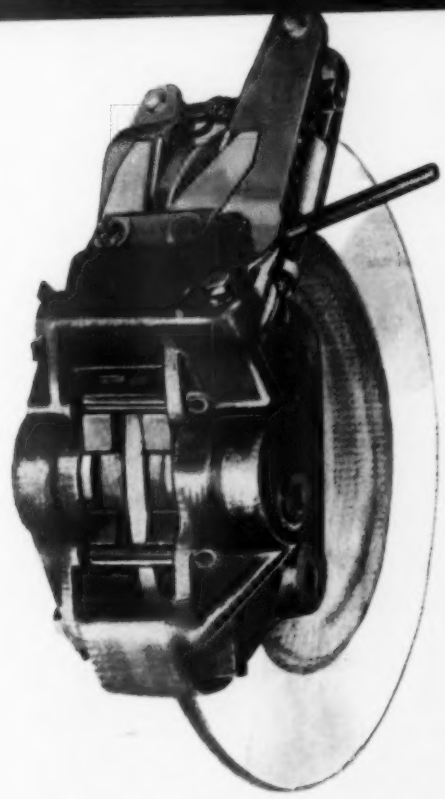

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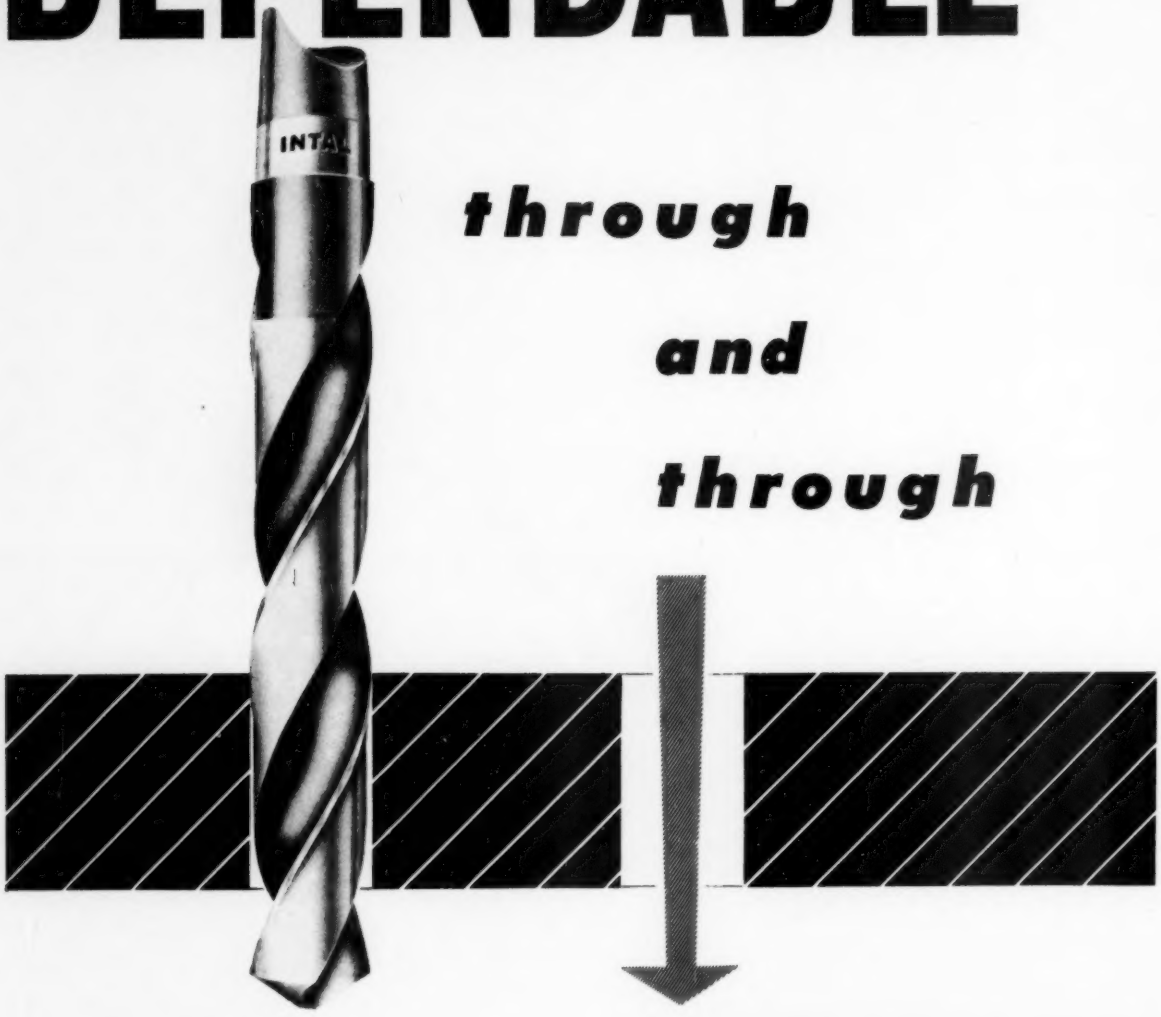

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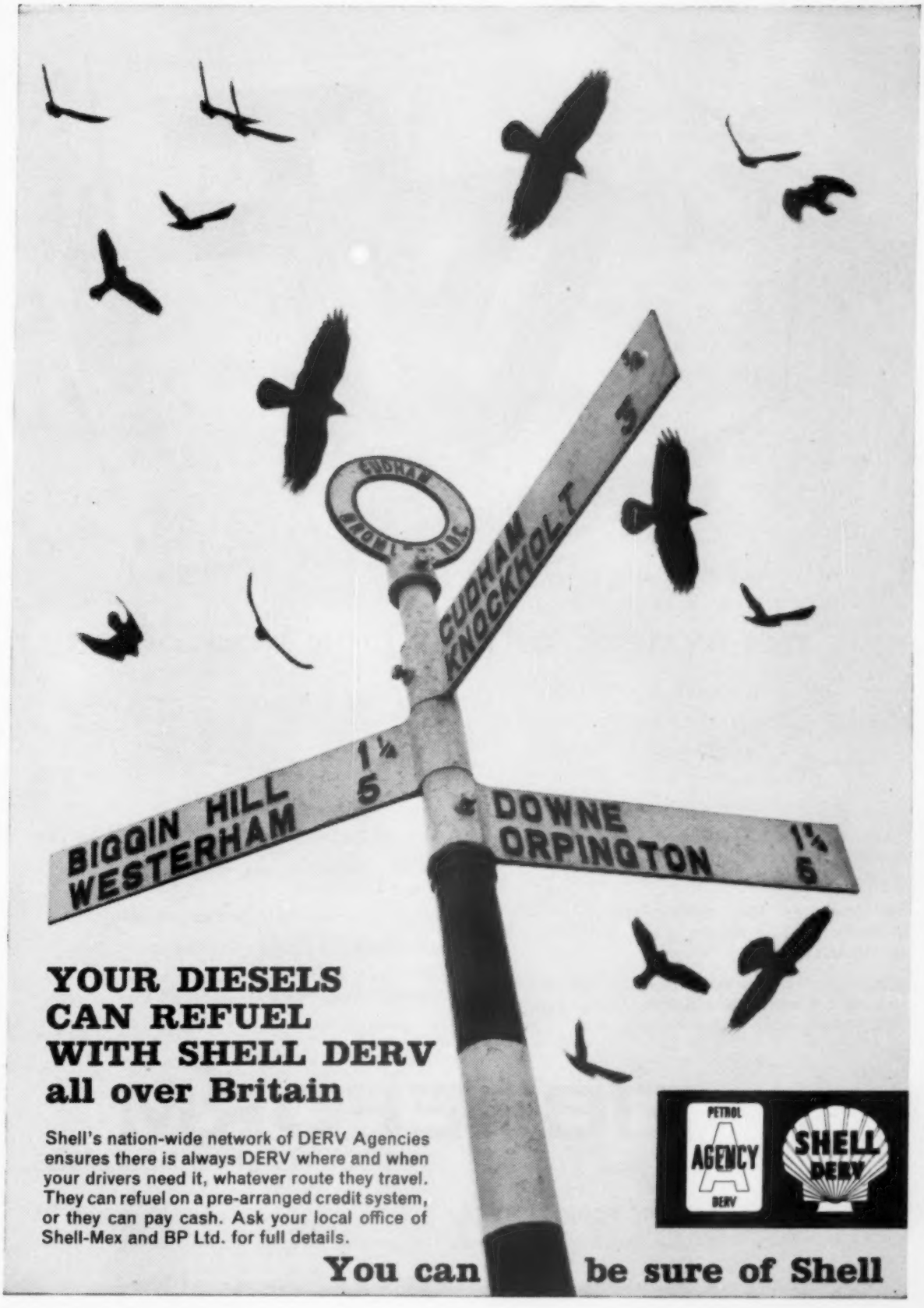
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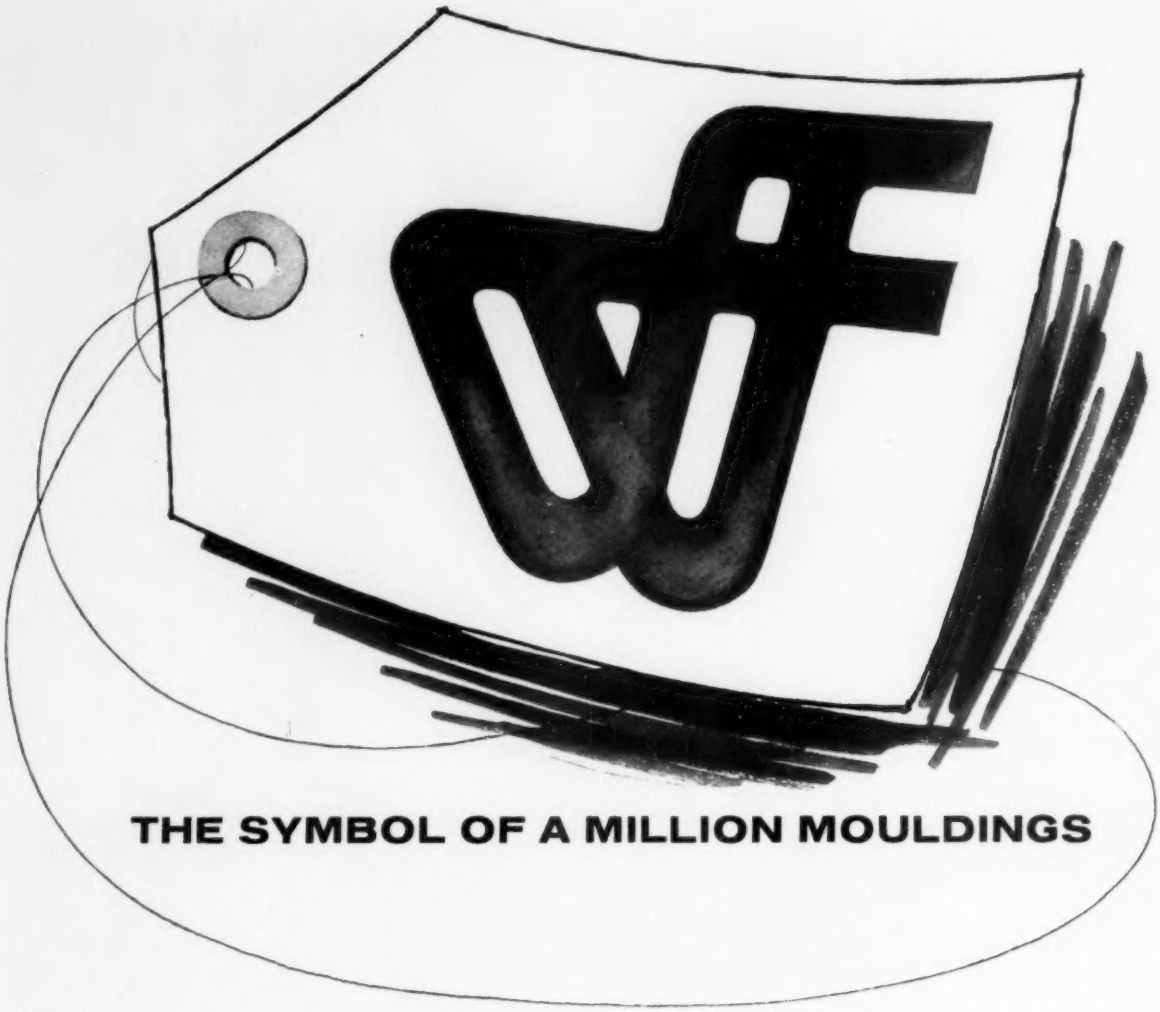

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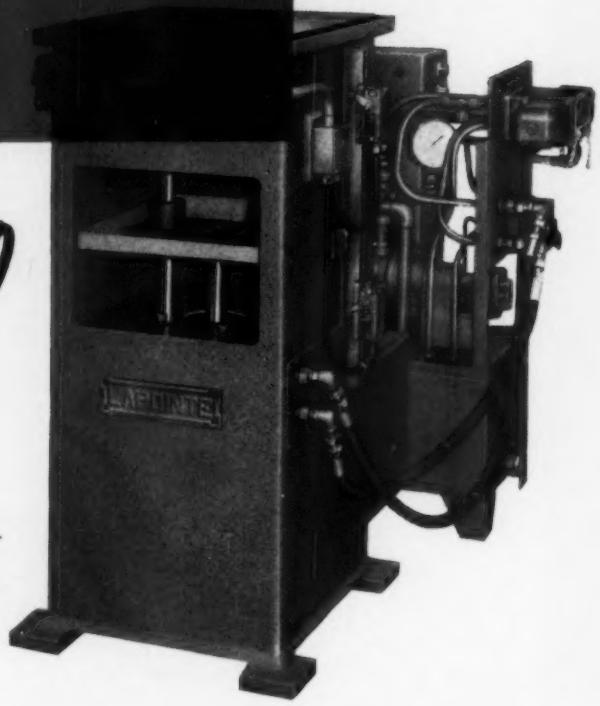

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Brief specifications:
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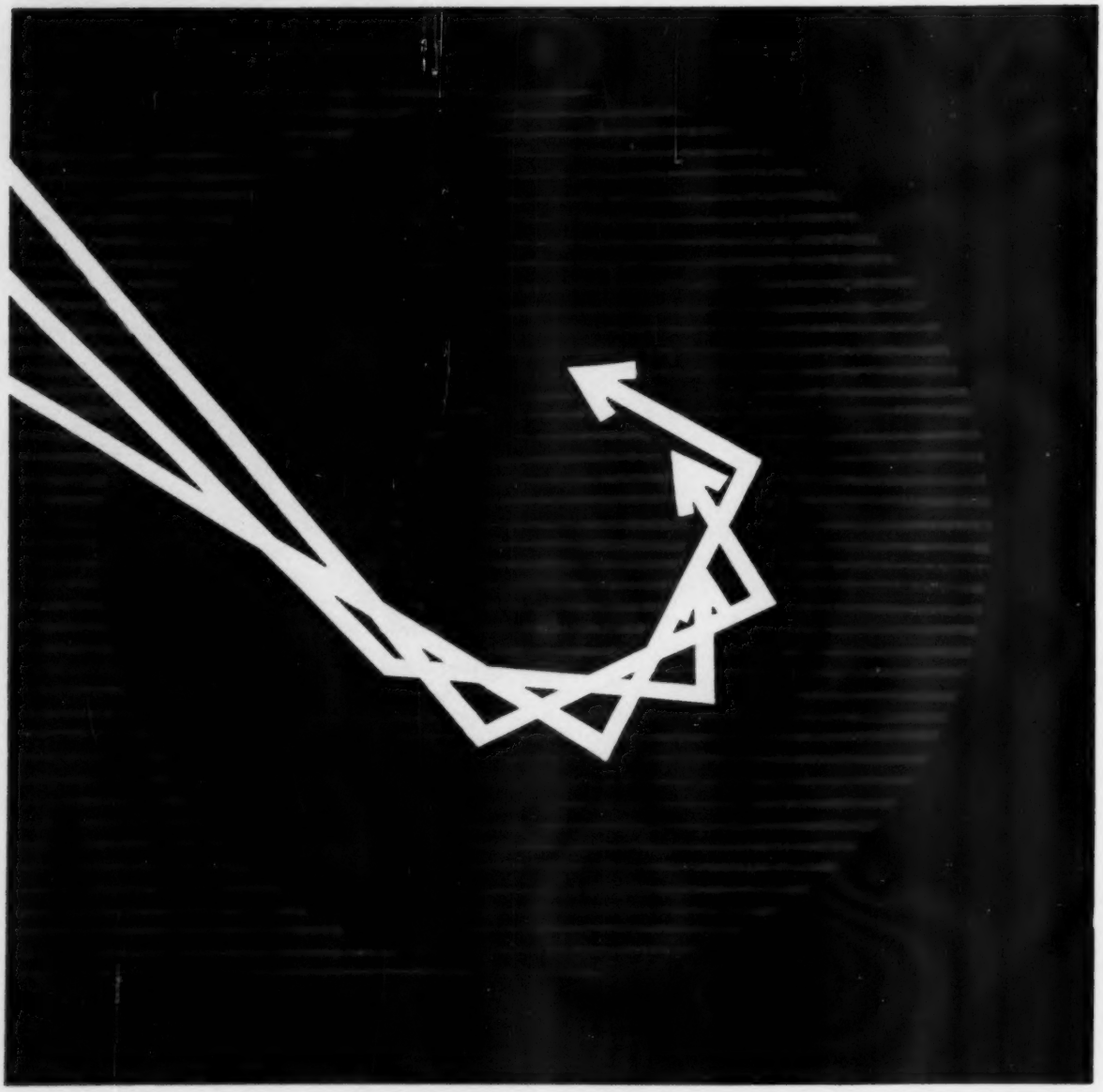

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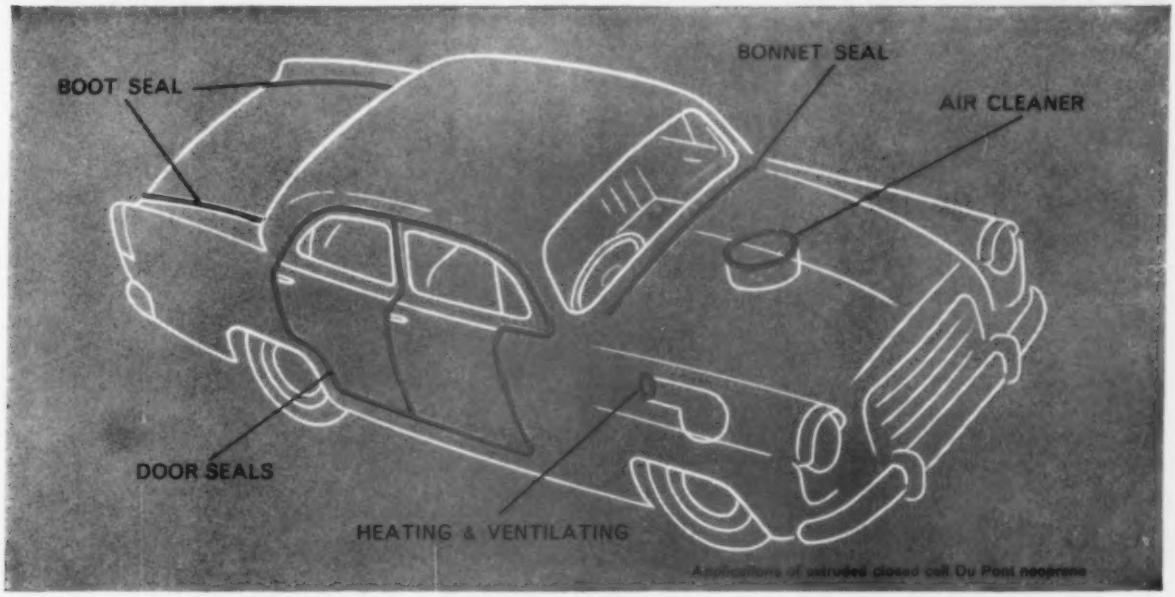
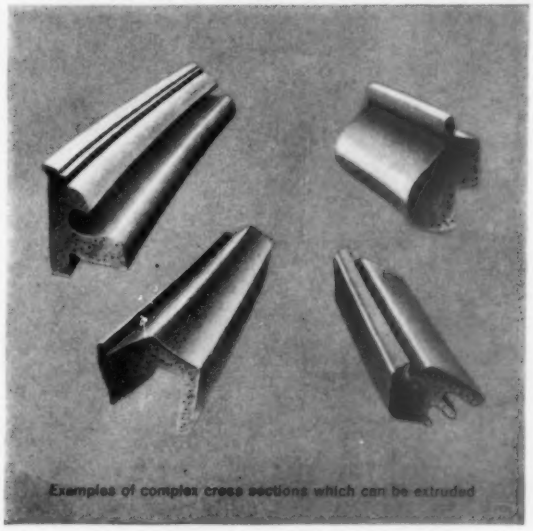


Applications of extruded closed cell Du Pont neoprene


Examples of complex cross sections which can be extruded

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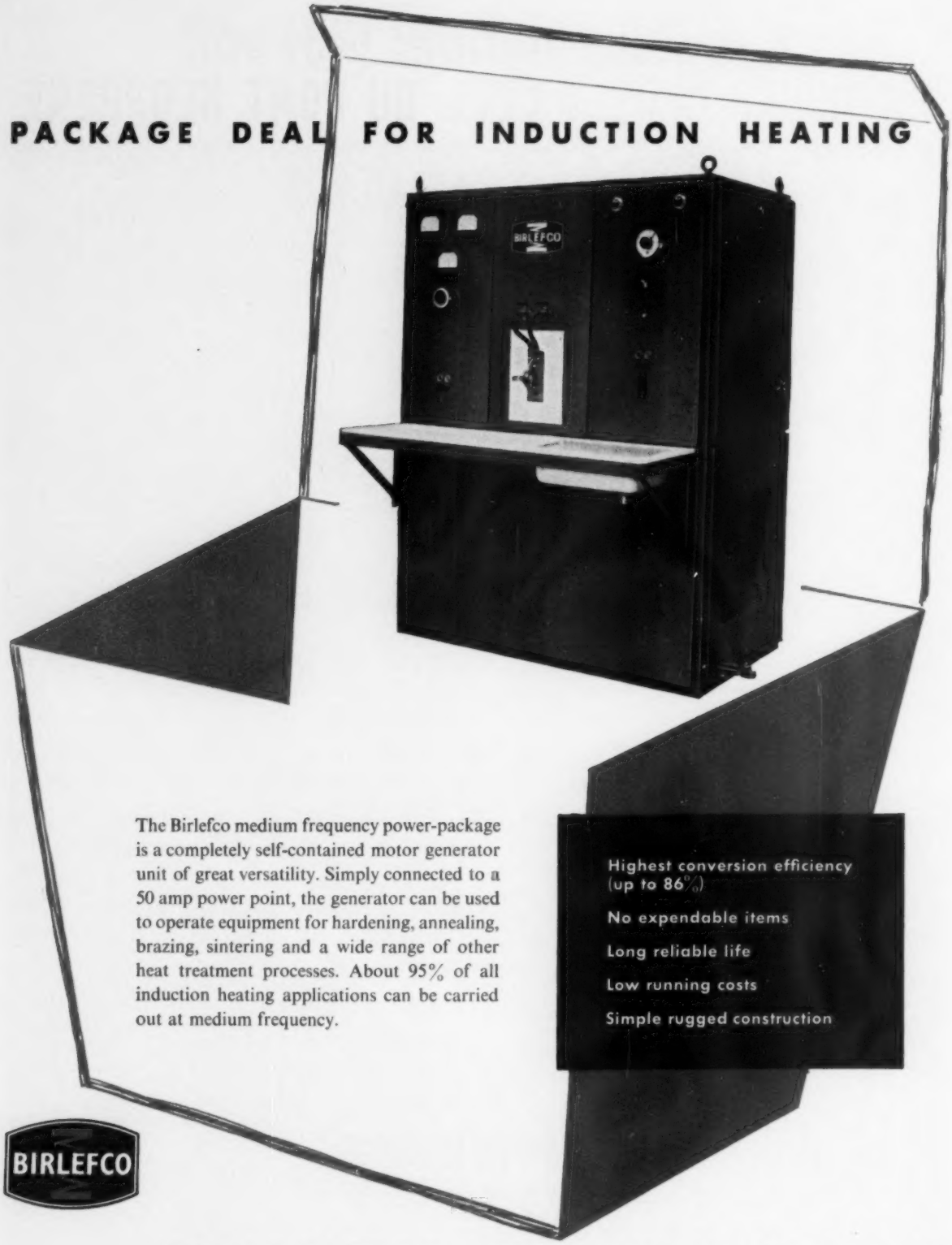

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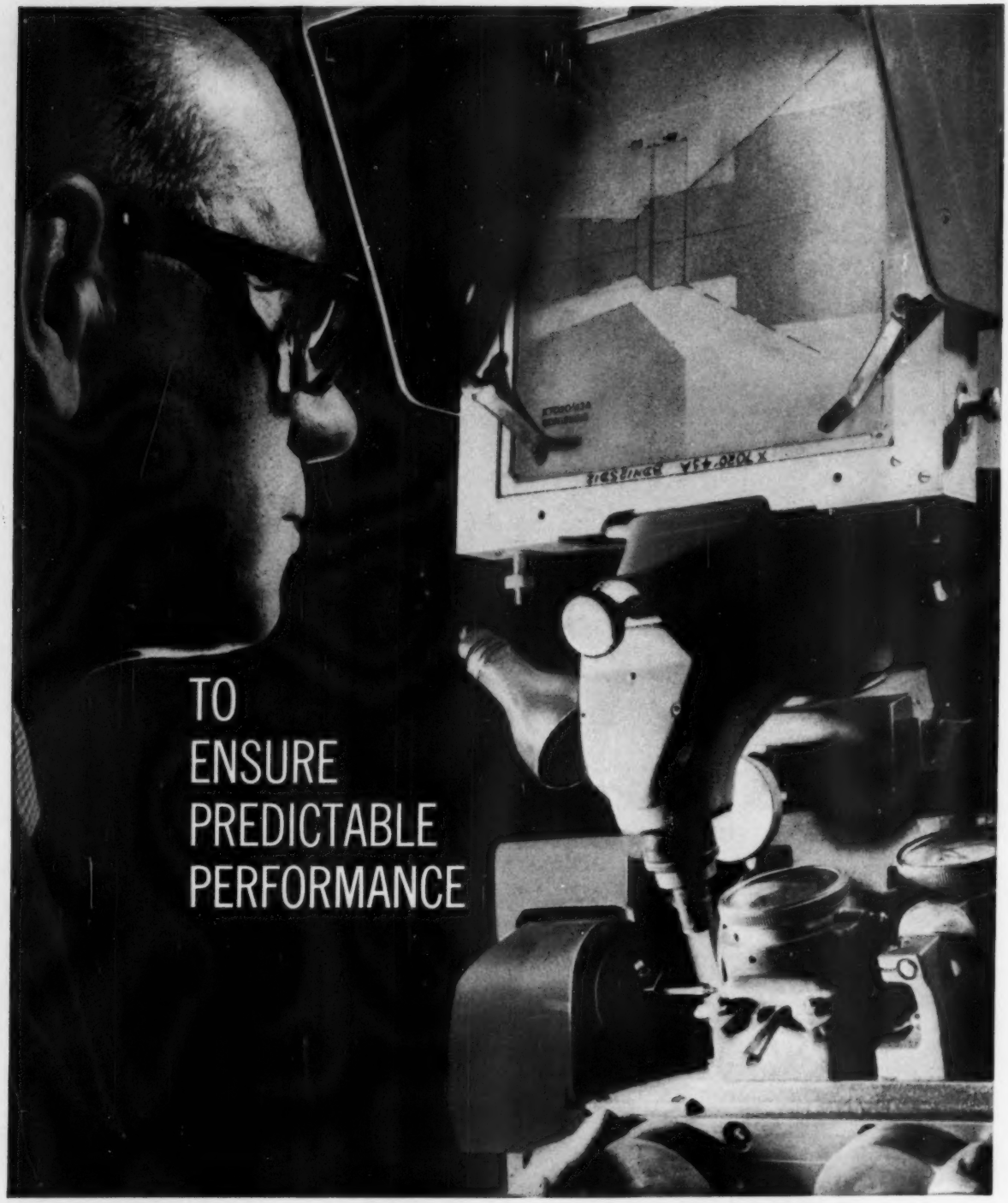

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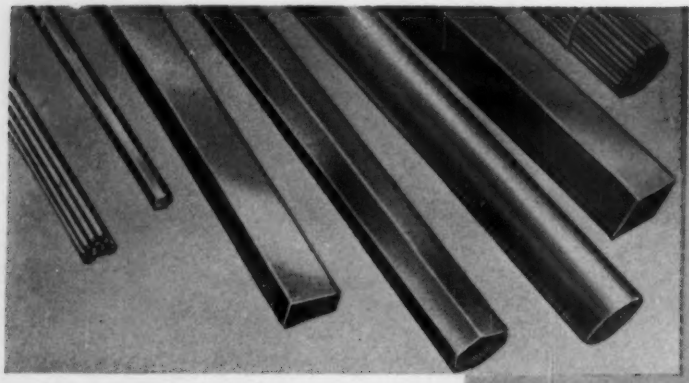

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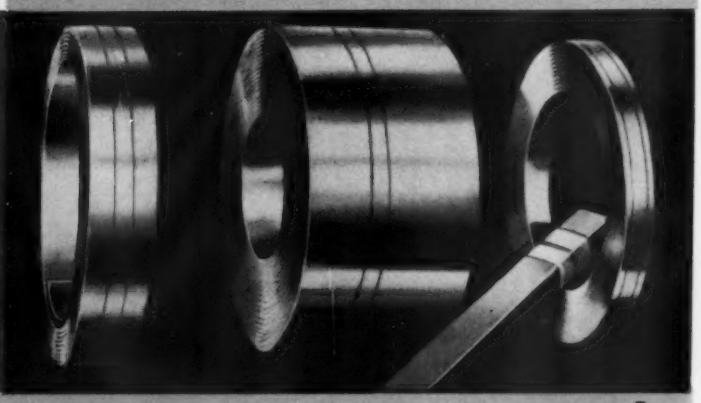

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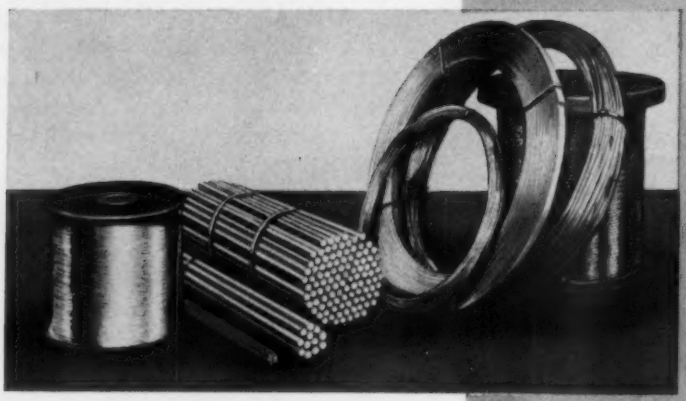
Drawn and Rolled for all purposes



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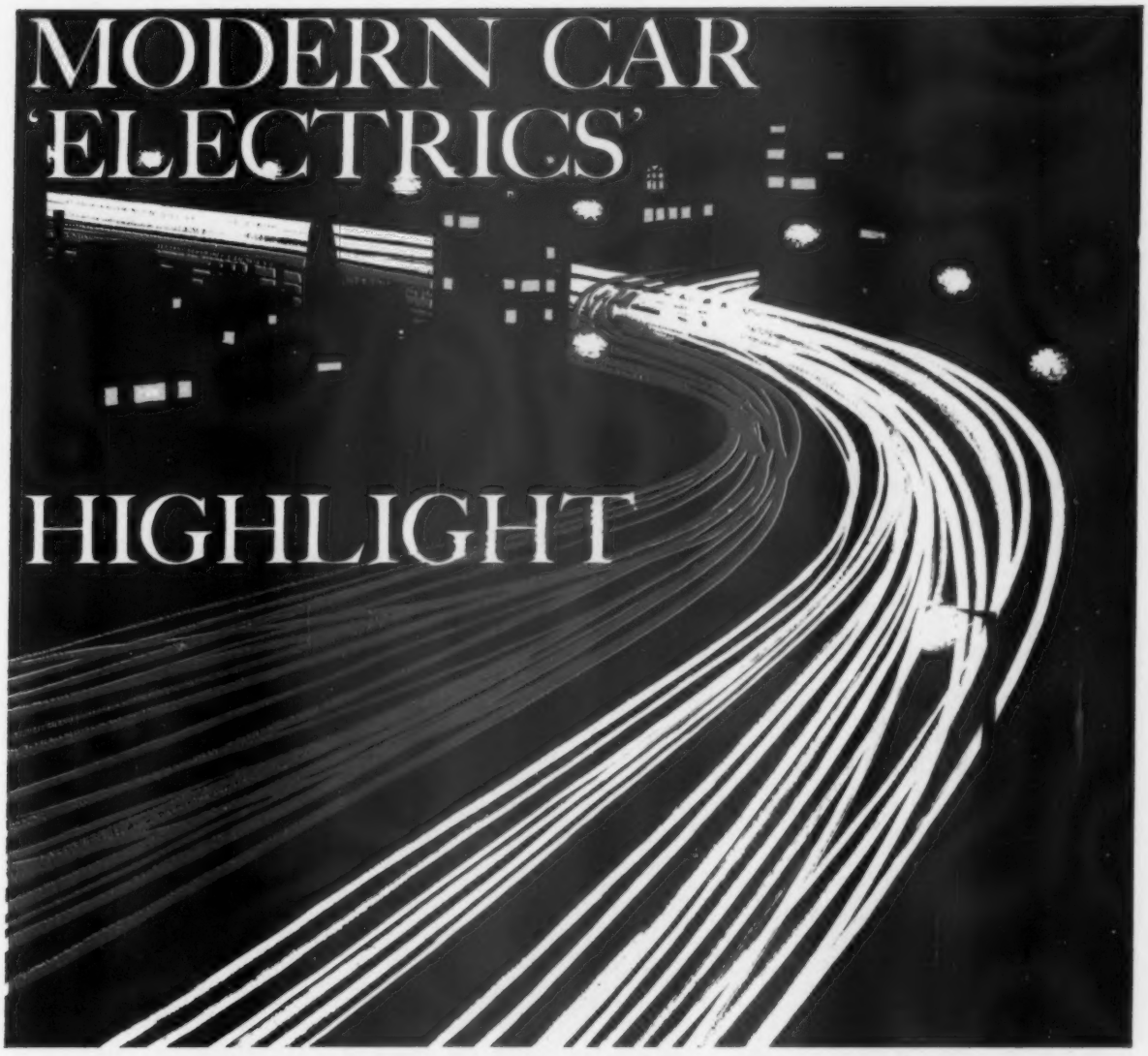
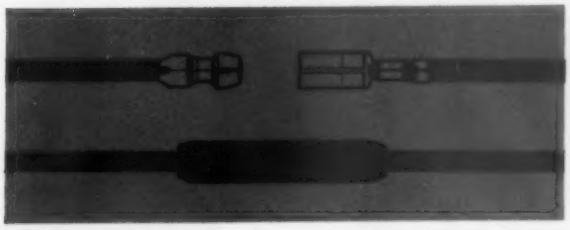


THE NEED FOR *A-MP



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made from I.C.I. ISOCYANATES AND POLYESTERS.
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Polyurethane foams provide excellent thermal insulation in all transport vehicles.
They combine high thermal resistance with lightness, strength and low inflammability.
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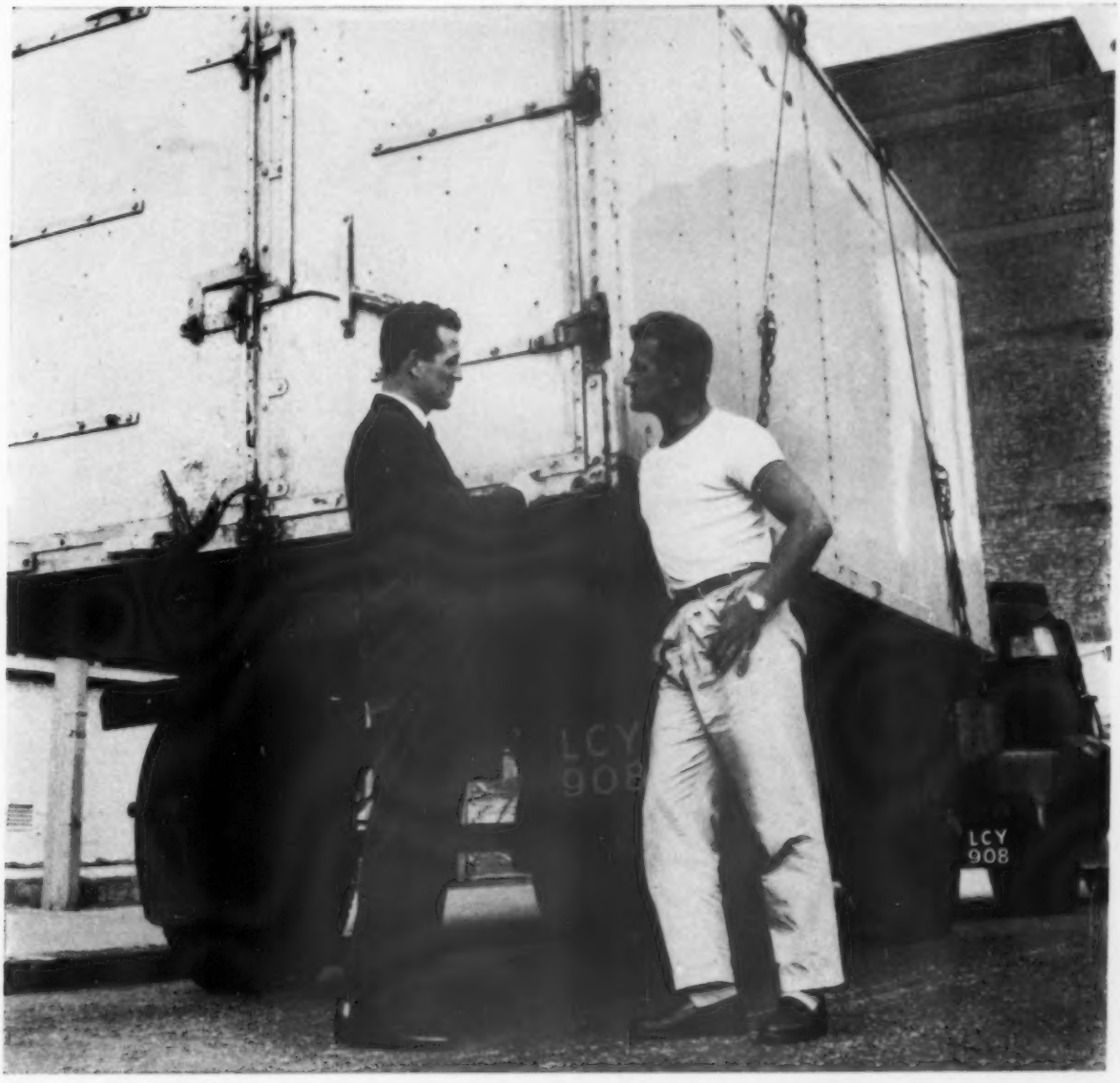

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bring new precision to linear motion

Just as you specify rolling bearings for rotary motion, so these **R & M** Ball Bushings bring you equivalent performance for linear movement. The self-contained re-circulating ball principle provides a neat compact unit as easy to handle and install as a plain bush. Leading companies in America have proved the value of Thomson Ball Bushings. Now they are made in Britain by Ransome and Marles Bearing Company under U.K. patent 707039.

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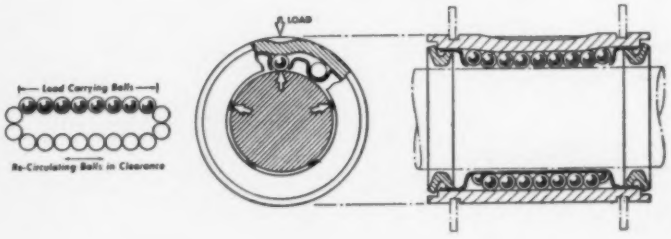

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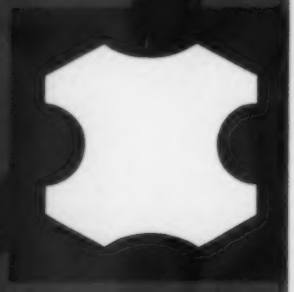

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NADELLA Needle Bearings
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PANHARD P.L. 17

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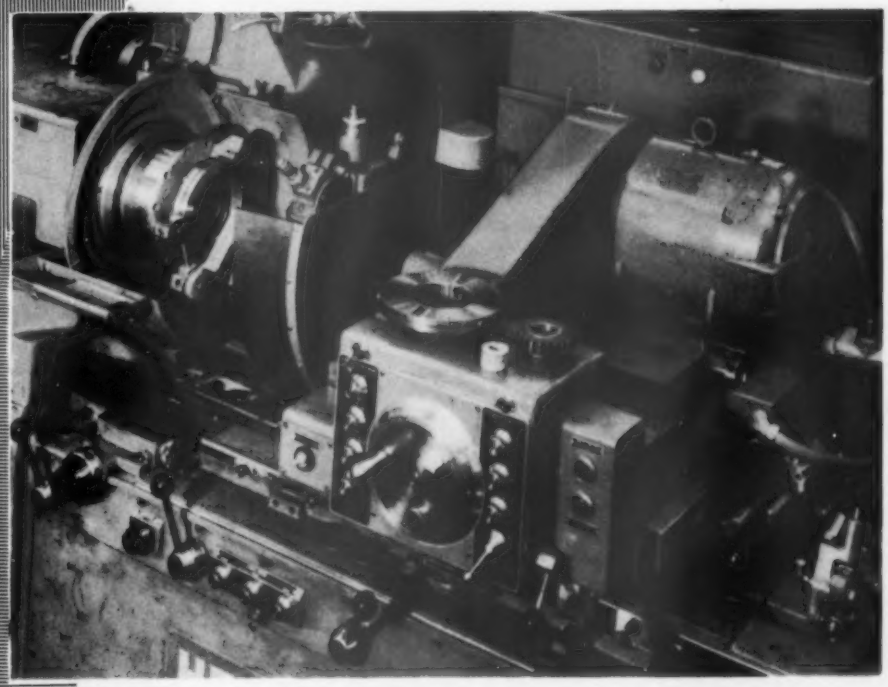
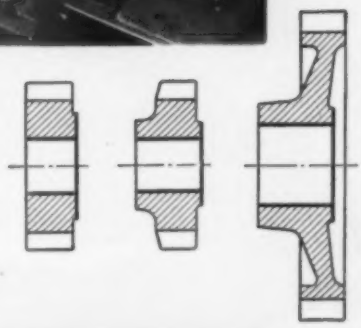
precision grinding four different gears in one set-up on one machine



These gears are of three different contours as shown. Finish in the bore is 15 micro-inch and on the face 20-25 micro-inch. Bore and face are square to .0005". Stock removal .012".

Gear is located in an adapter and held in a pneumatic diaphragm chuck. Bore is ground with table reciprocation and standard Sizematic cycle. When finished to size wheelhead is indexed forward and face is plunge ground with the facing attachment.



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The casting illustrated is a clutch withdrawal ring as supplied to Leyland Motors Ltd.

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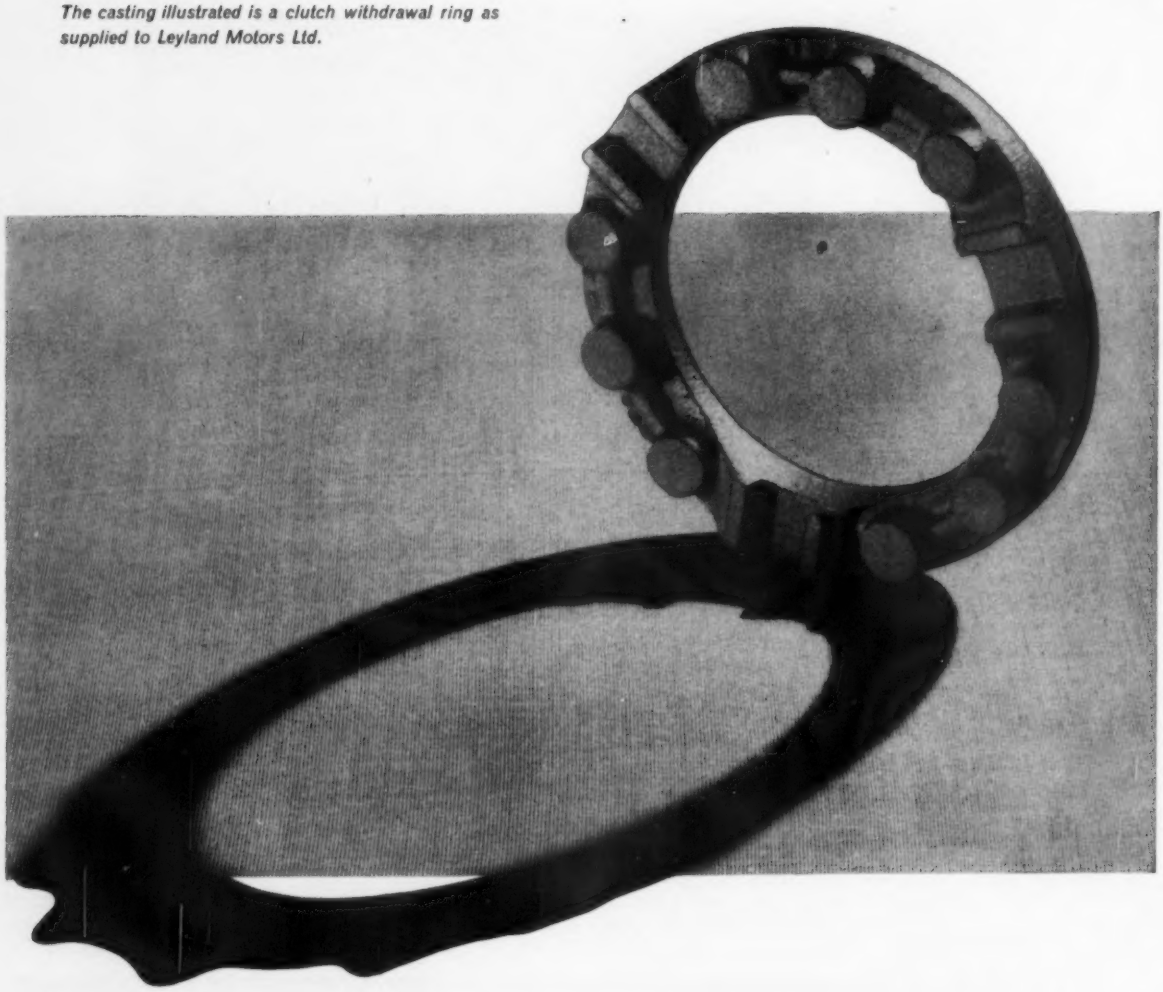

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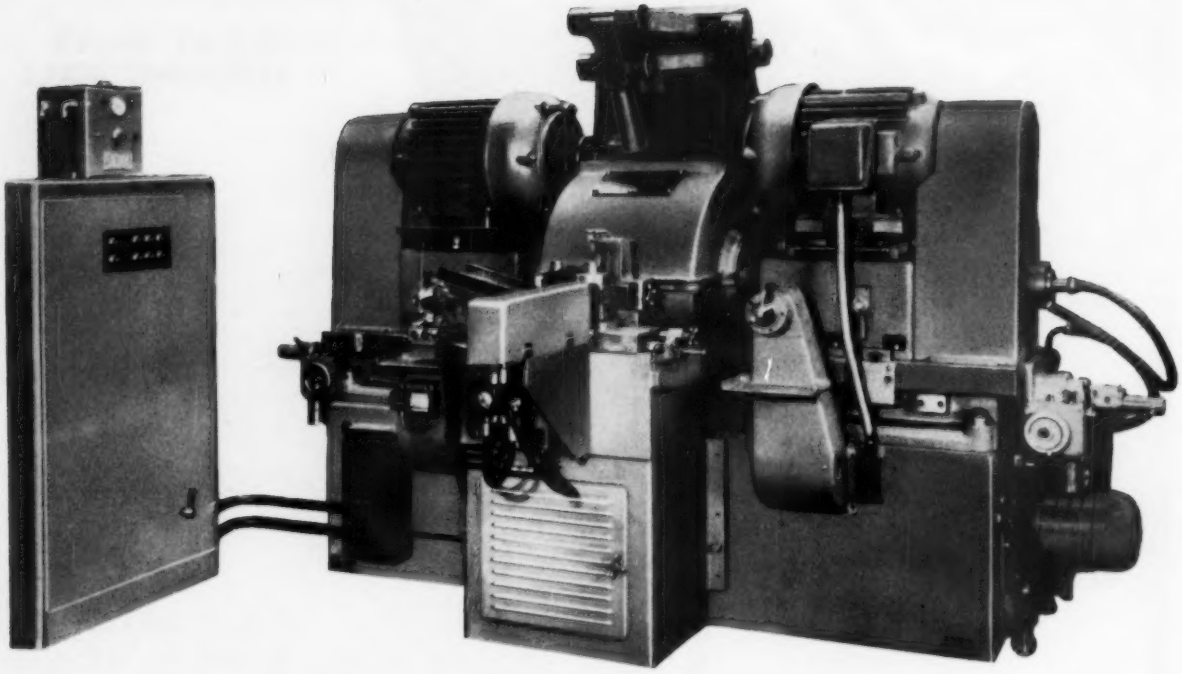

Capable of high stock removal whilst maintaining fine finish and close limits

These machines reduce production costs by grinding two parallel surfaces at one operation. Workpieces are carried between the abrasive discs by methods which depend upon the size, or geometry of the component and feeding arrangements range from manually operated systems to automatic loading devices with automatic sizing.

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for mass production in the

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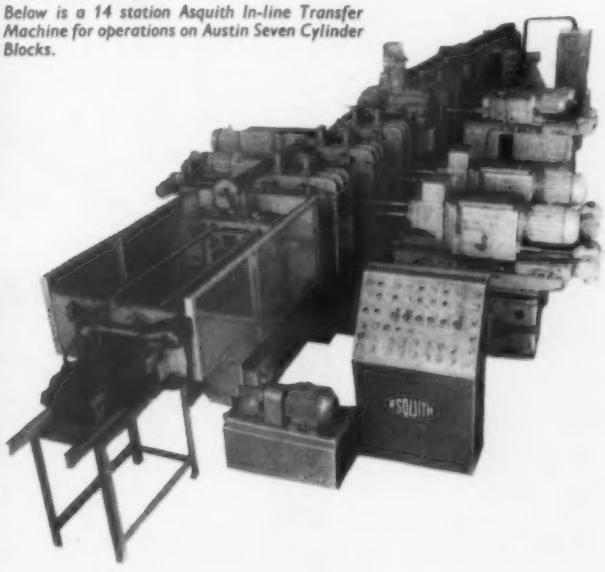
On the left is an Asquith 30 working station In-line Transfer Machine for operations on 5 types of cylinder heads at Ford Motor Company Ltd., Dagenham.

Below is a 14 station Asquith In-line Transfer Machine for operations on Austin Seven Cylinder Blocks.



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FREQUENCY RANGE
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TOTAL STROKE
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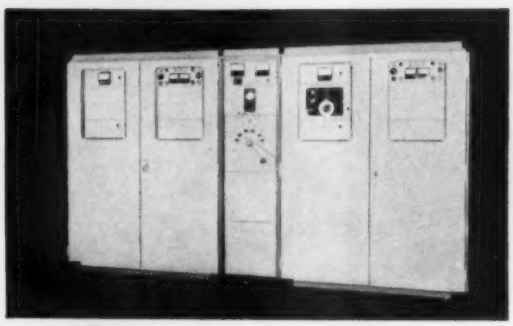

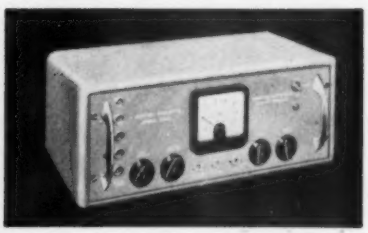

Illustrated left, is a PA 20KVA Power Amplifier; and above, the E501 'g' Control Amplifier.

*

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GOODMANS *the vibration specialists*

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CARTER STEVENS (AUTOMATION) LIMITED

at Coventry, half way between the two. Desoutter will make the Tools. Lang will make the Valves and Cylinders etc to operate the Tools; Carter Stevens make sure that the whole thing works untouched by 'uman 'ands.

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CRC 340

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AEC Bridgemaster King-pin assembly fitted with DU bushes.

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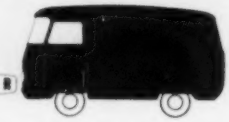
* Glacier DU dry bearings are composed of thin steel strip with a porous bronze coating impregnated with a mixture of a fluoro-carbon plastic (P.T.F.E.) and lead.

GLACIER

D.U. for COMMER



DU Thrust washers fitted as standard equipment on the ¾ ton range of vehicles.

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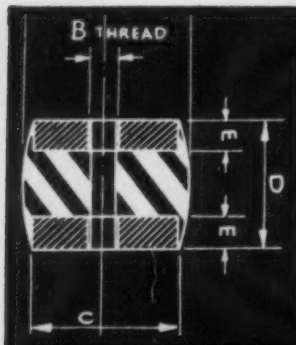

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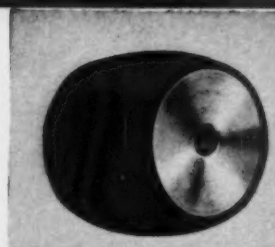

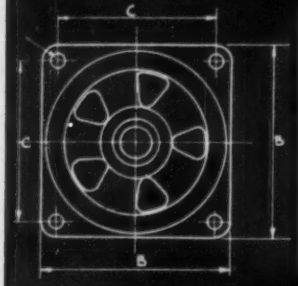

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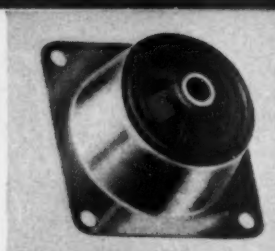

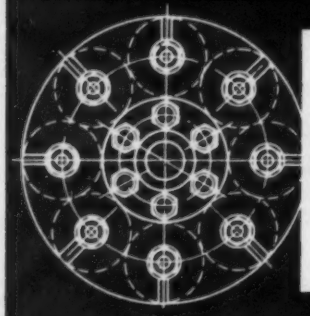

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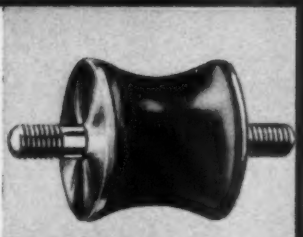

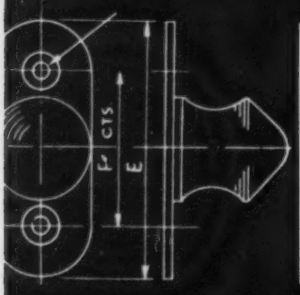

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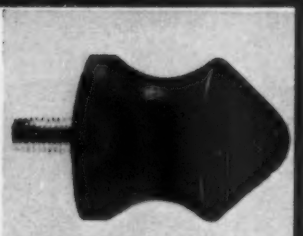

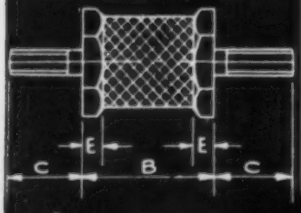

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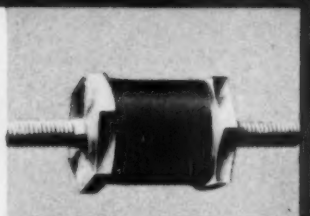

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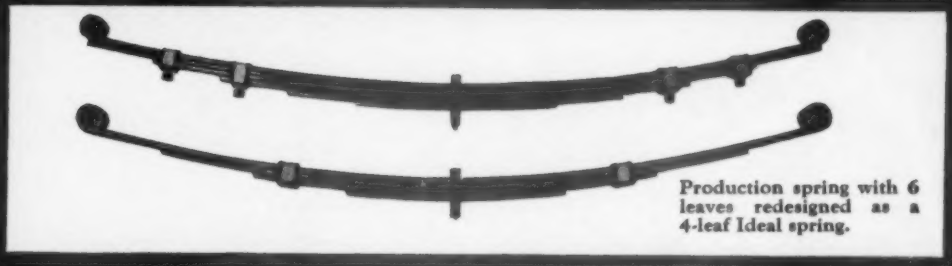
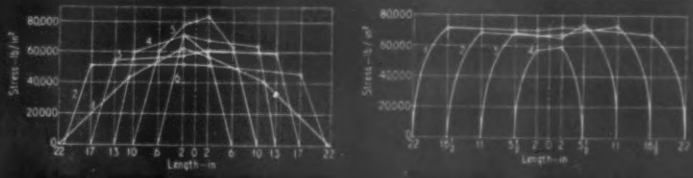
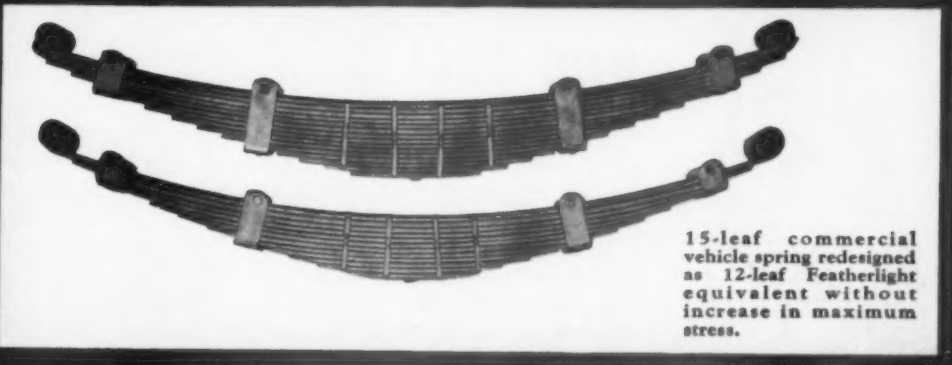
HOW TO SAVE SPRING WEIGHT WITHOUT INCREASING STRESS

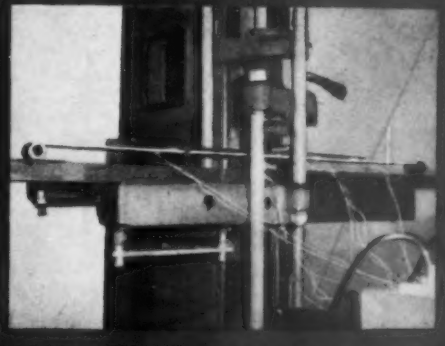


Production spring with 6 leaves redesigned as a 4-leaf Ideal spring.





15-leaf commercial vehicle spring redesigned as 12-leaf Featherlight equivalent without increase in maximum stress.



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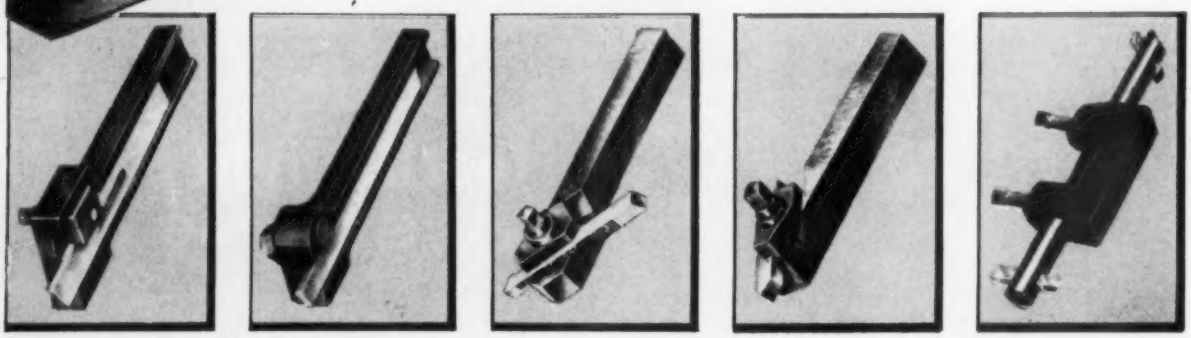

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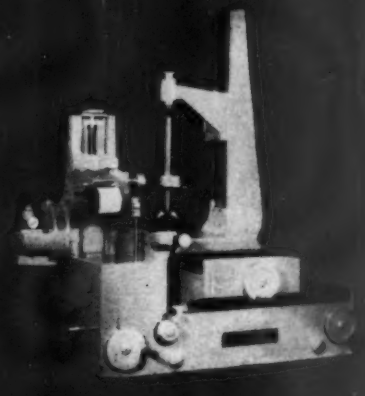

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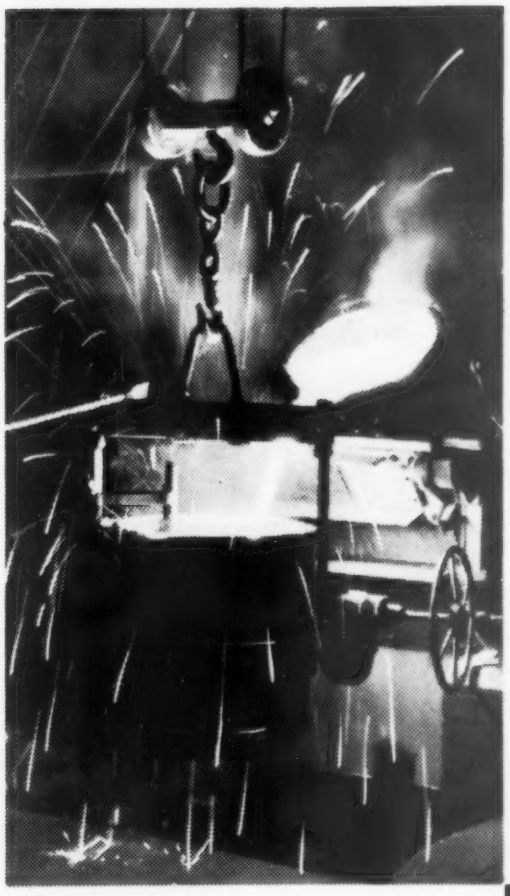

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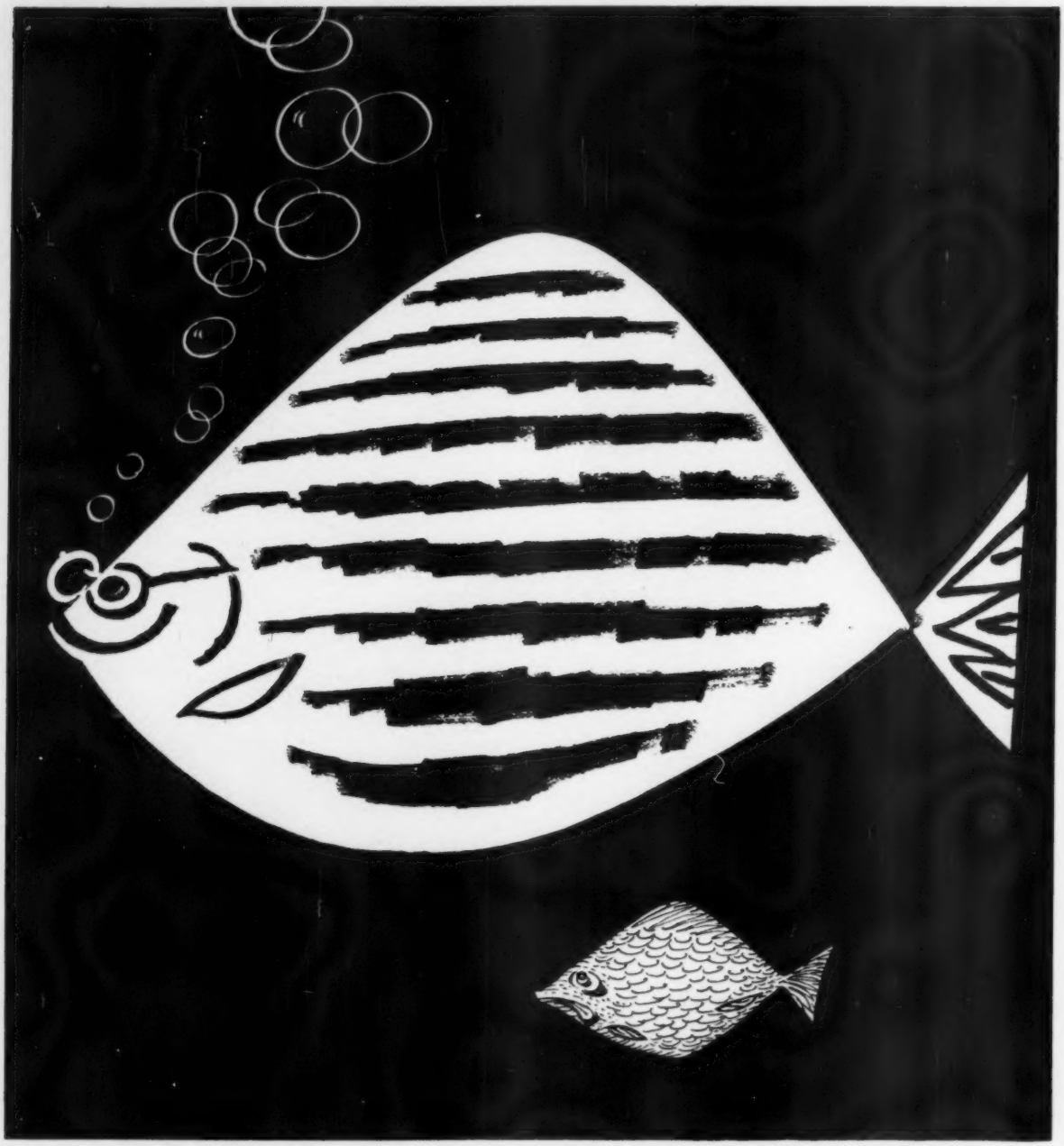

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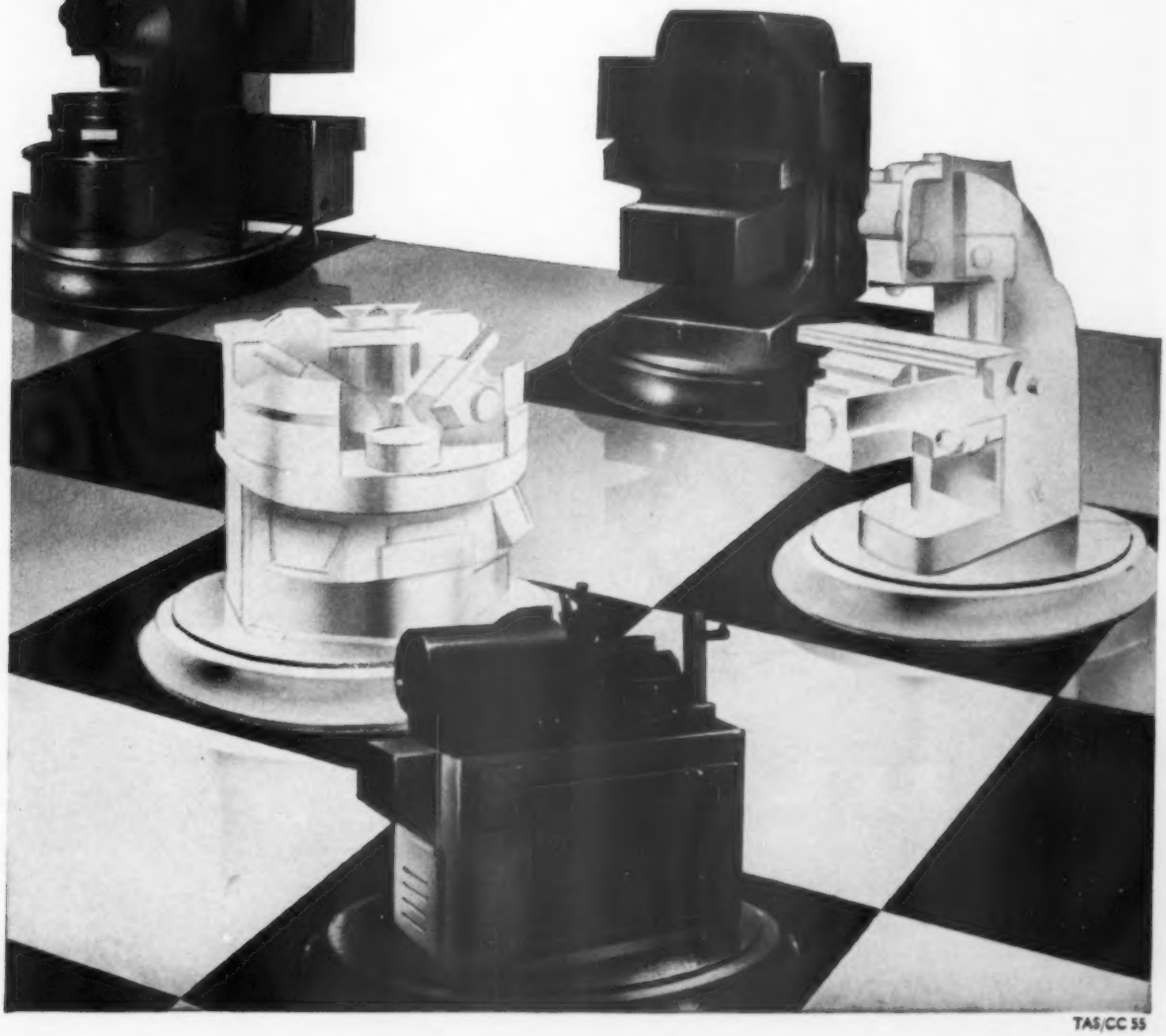

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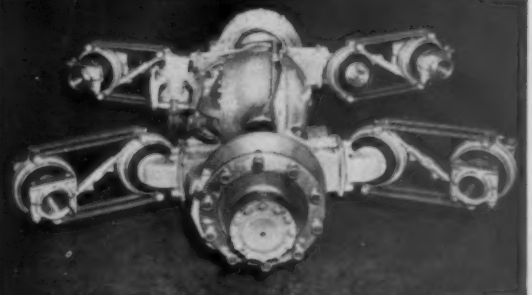

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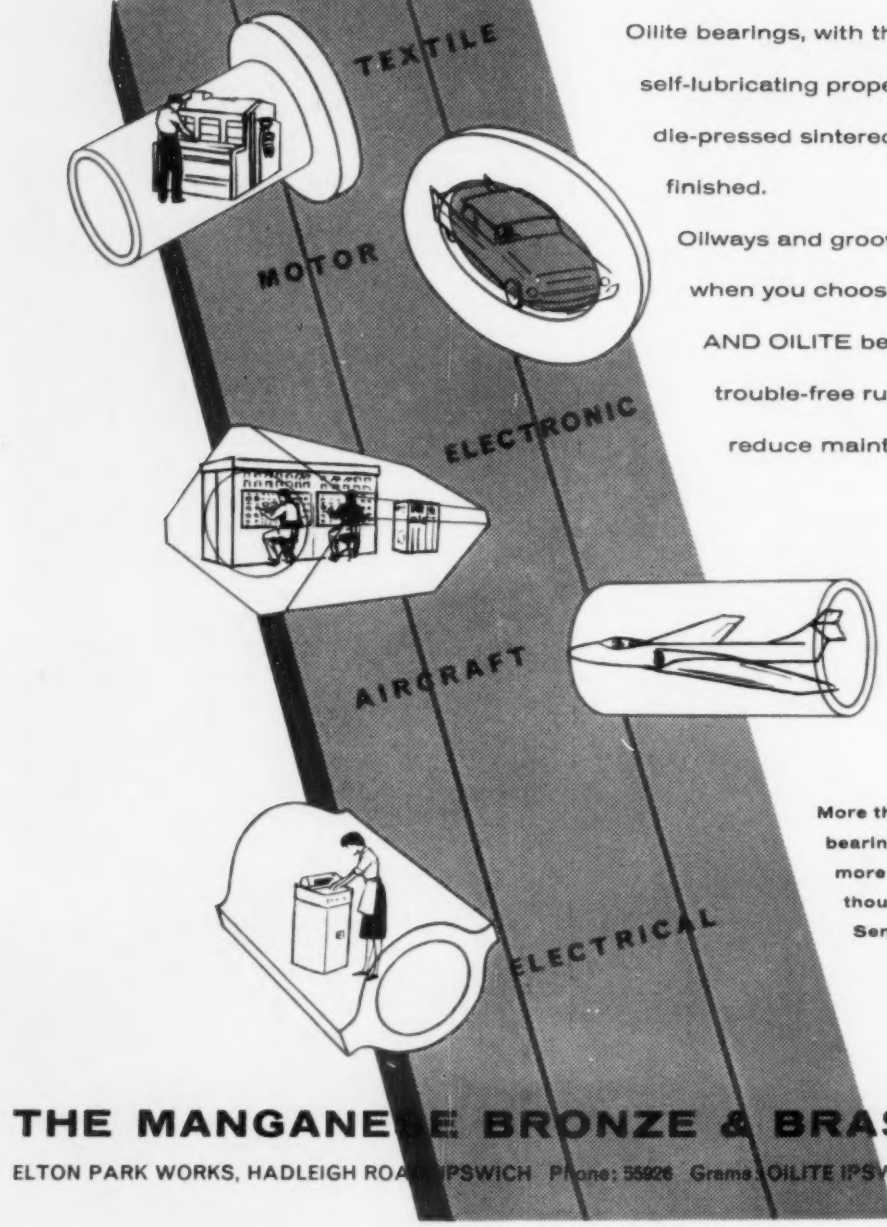

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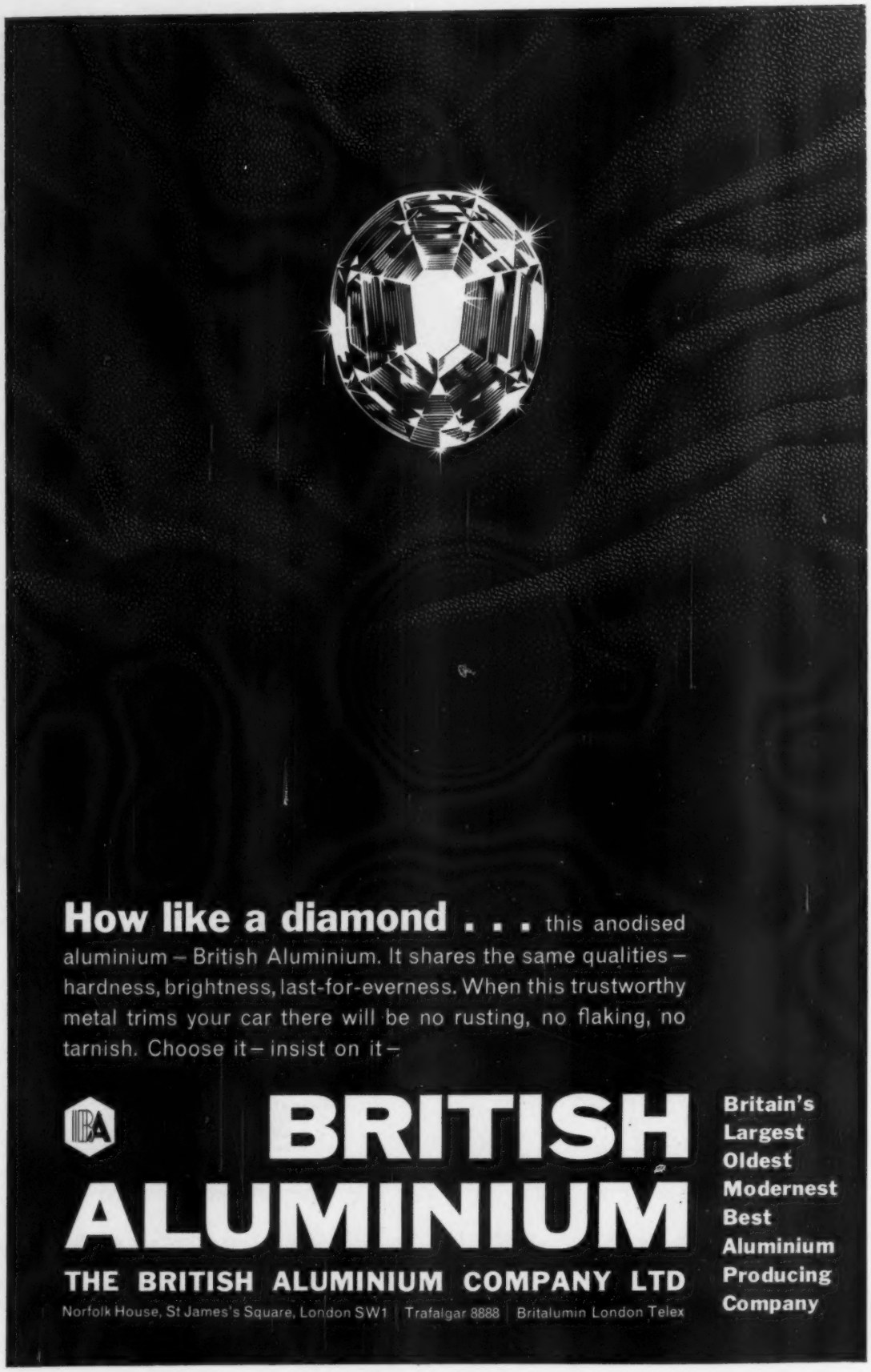
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Speed control of Electric Motors

'Variable' speed may involve two or three (or more) speed steps or infinitely variable (stepless) speed control. It is this latter type which is considered below. Of the many advantages of electric drives, the opportunity offered for infinitely variable speed control is outstanding. Unfortunately this advantage is not used as much as it might be to increase the speed of working, and to improve productivity and quality.

Principal Factors Affecting Choice of Drive

(a) First cost, (b) Efficiency, (c) Speed range, (d) Regulation, (e) Power-to-weight ratio, (f) Availability of supply, (g) Maintenance and reliability, (h) Change in power and torque over the speed range, (i) Simplicity of control gear, (j) Effect of variation in supply, (k) Power factor, (l) Characteristics of the load, (m) Operational environment, (n) Braking requirements.

This list is not meant to be all-embracing, for there well may be factors not mentioned which could prove conclusive in the choice of a drive.

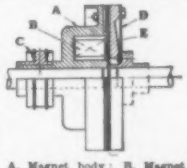
The following are some methods of obtaining infinitely variable speeds:

Alternating Current Motors

The vast majority of electric drives in use today employ A.C. motors. Although not quite so flexible as D.C. motors in the matter of speed control, there are available many types which give a large measure of speed variation.

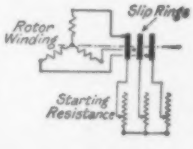
INDUCTION MOTORS. Although the squirrel-cage motor is essentially a constant-speed machine, it is much used for stepless variable speed drives with one of the following types:

(a) Eddy-current coupling,
(b) Ferro-magnetic particle coupling,
(c) Mechanical drives, e.g. belt drives and friction drives,
(d) Hydraulic variable speed drives.



A, Magnet body; B, Magnet coil; C, Collector gear; D, Spring plate; E, Armature.

SLIP-RING MOTOR. The slip-ring motor, which costs more than the squirrel-cage motor, can be varied in speed by means of the resistors in the rotor circuit used for starting. The amount of resistance in circuit can be varied in steps by means of different forms of control gear operated by hand, push-button or automatically controlled contactors.



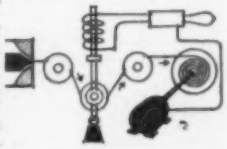
A.C. COMMUTATOR MOTORS. These are three-phase induction motors provided with additional windings which, through a commutator and brushes, permit speed adjustment in either direction below and above synchronous speed. The brush gear can be automatically controlled so as to vary the speed according to a known programme or cycle of operation such as in spinning frames. The Schrage and similar motors are refinements of this type.

Ward-Leonard System

In this system the armature of a D.C. motor is supplied at variable voltage from a separate generator. The generator may be driven by an A.C. or D.C. motor directly coupled to it and to an exciter which supplies the field windings of the generator and main motor. By means of a potentiometer resistance, with mid-point connected to one terminal of the generator field windings, the generator voltage may be varied from maximum to zero.

Electronic Motor Control

Motor speeds can be controlled accurately by electronic methods. Such drives can respond in any desired manner to variations in one or more variables and several drives can be interlocked so that their speeds are always in the same ratio. A typical application is on several separate conveyors. The system can be speeded up or slowed down from a 'master' controller, but for 'running in' purposes the speed of each drive can be individually regulated. Electronic speed control has been successfully applied where human control is not possible, e.g. in register control. In this example print must always be placed at exact positions on packaging material. The sketch shows electronic control of wire tension in drawing operations.



Direct Current Motors

While it is unlikely that a mains supply of D.C. will be available, the striking advantages of D.C. motors sometimes make it worth while installing a rectifier, e.g. a motor-generator set, a mercury-arc or a semi-conductor. The speed of D.C. motors is easily controlled by inserting a resistance in series with the motor. Although this can result in a certain amount of wasted electricity, the benefits derived will often heavily outweigh such losses.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available —'Electric Motors and Controls' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

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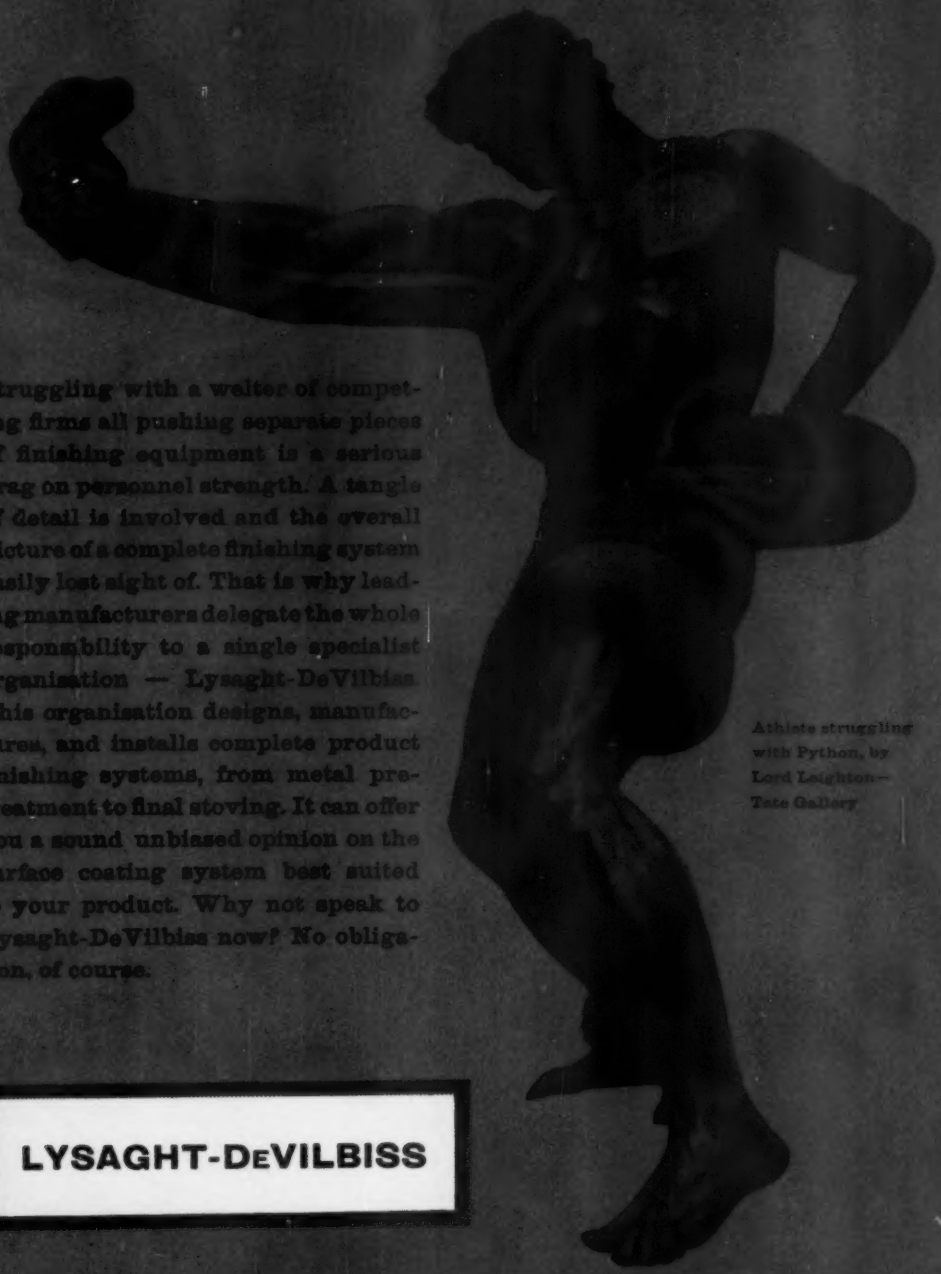
The art of disengagement



Athlete struggling with Python, by Lord Leighton—Tate Gallery

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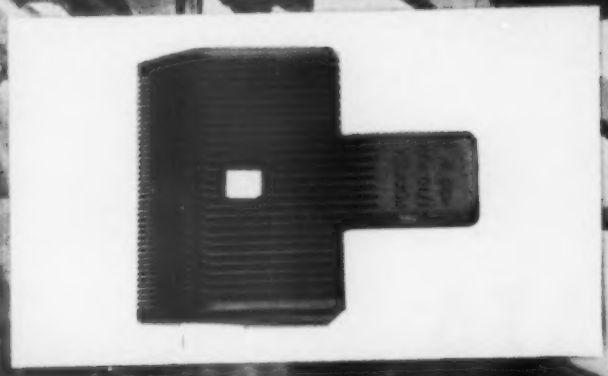

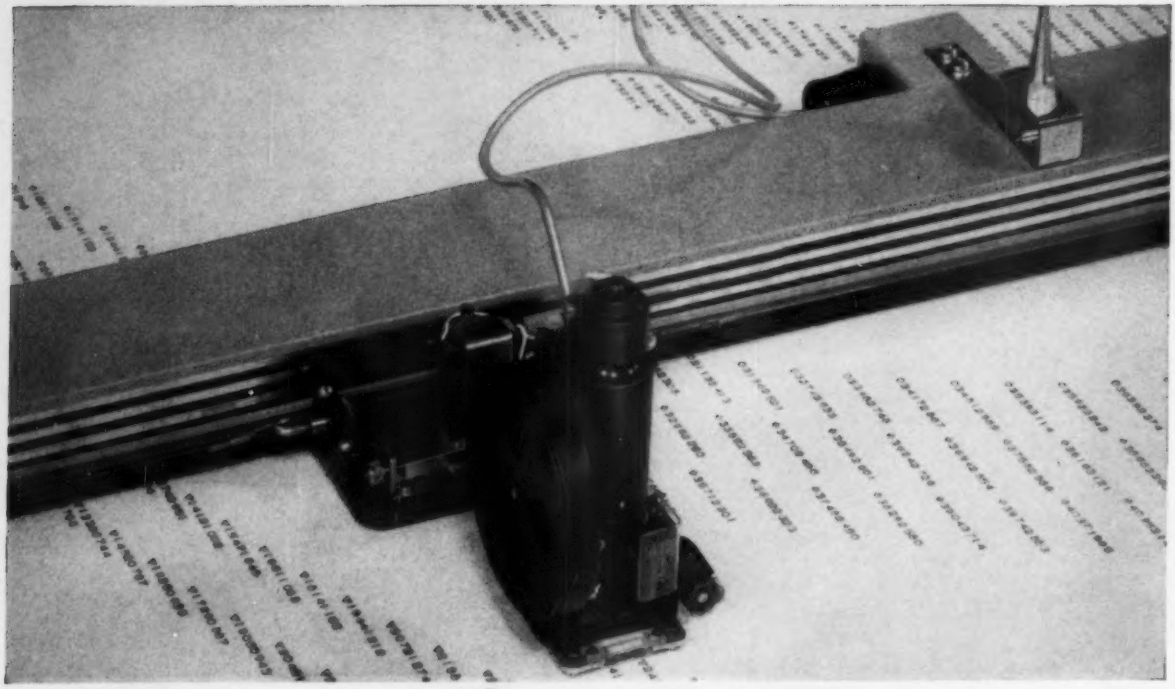

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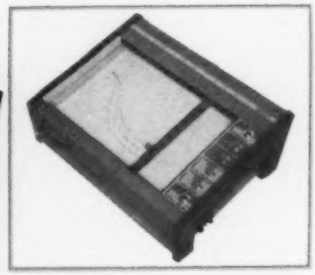

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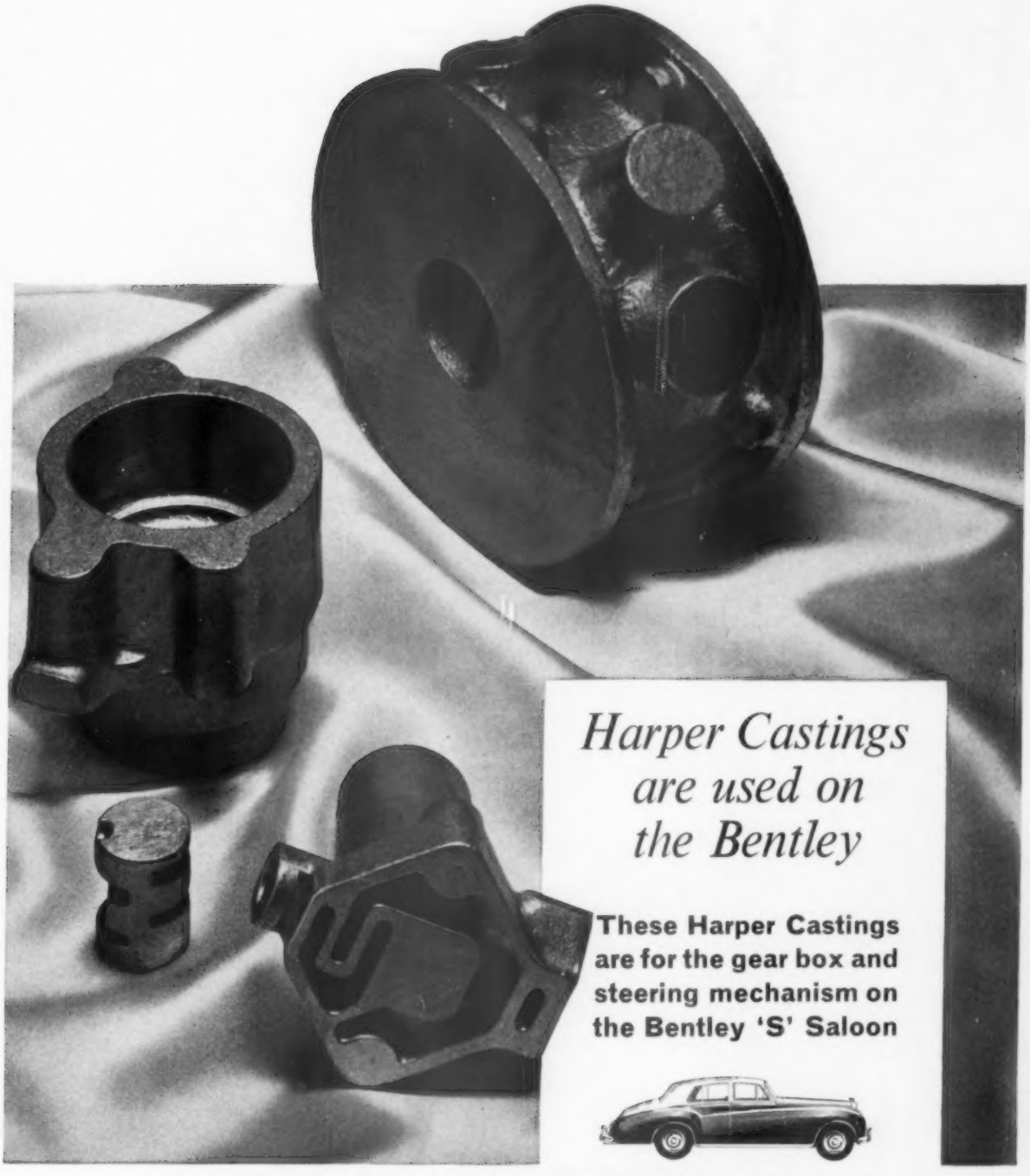

Harper Castings are used on the Bentley

These Harper Castings are for the gear box and steering mechanism on the Bentley 'S' Saloon

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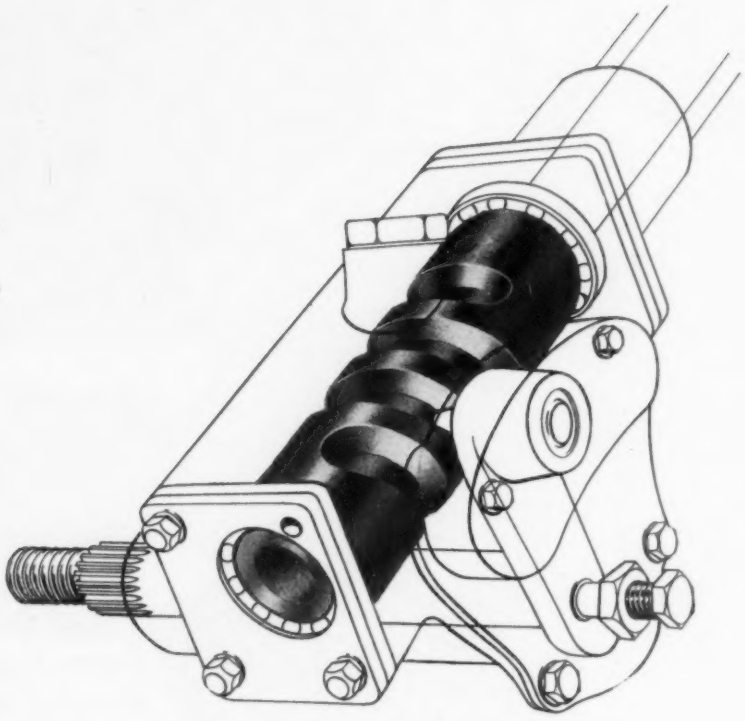

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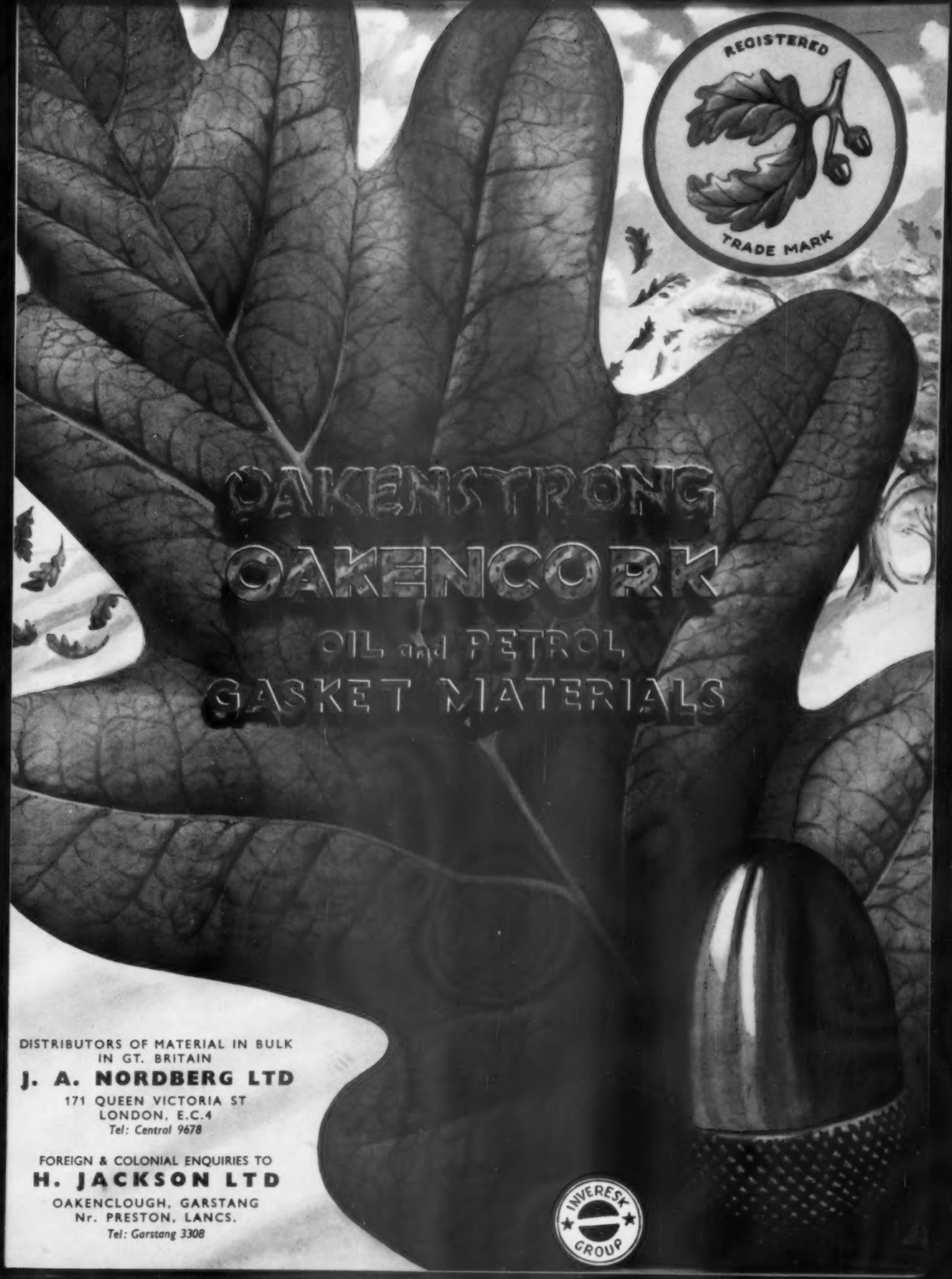

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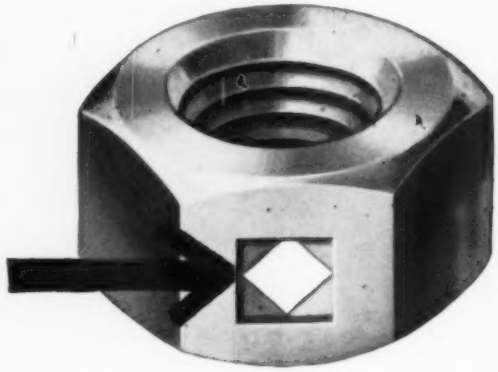

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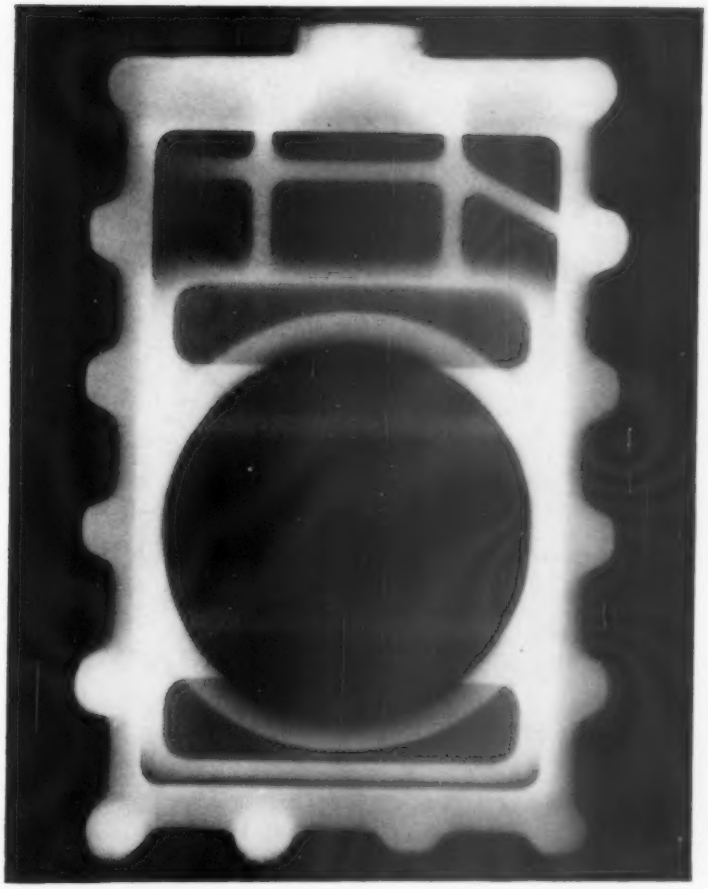

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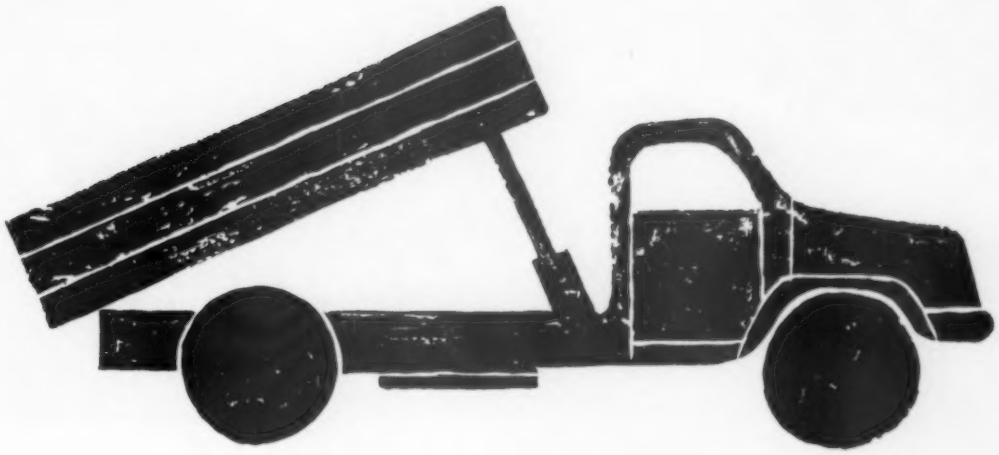

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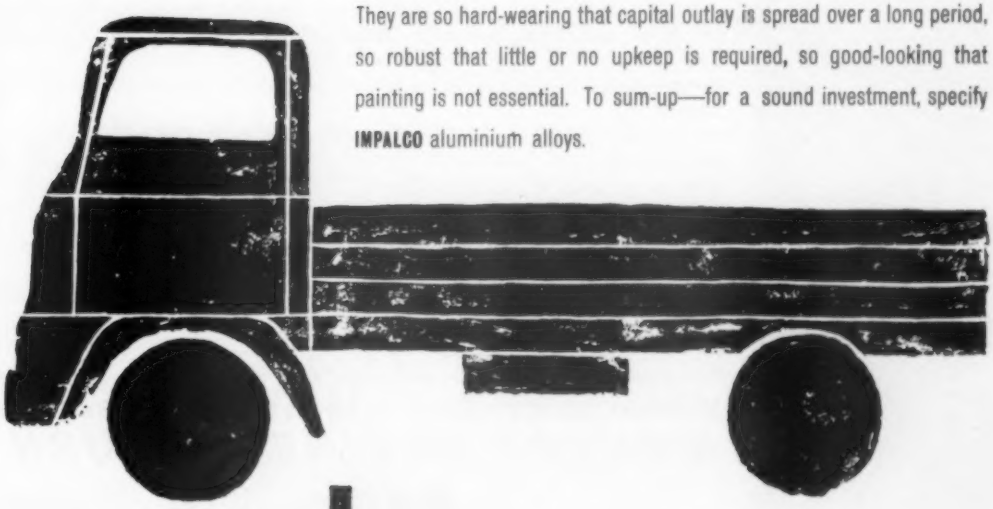

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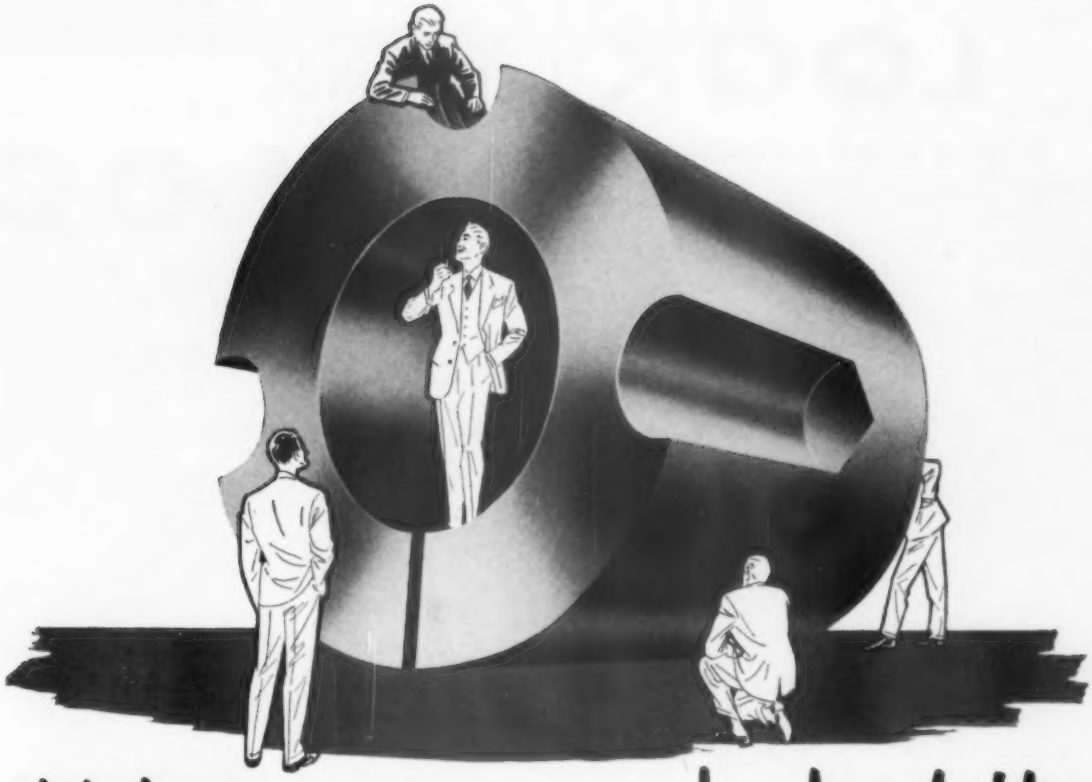

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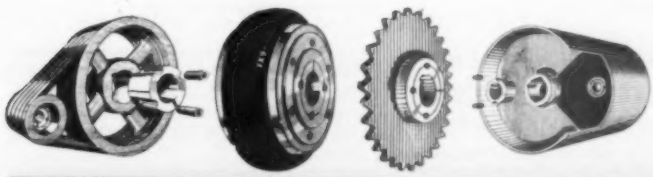

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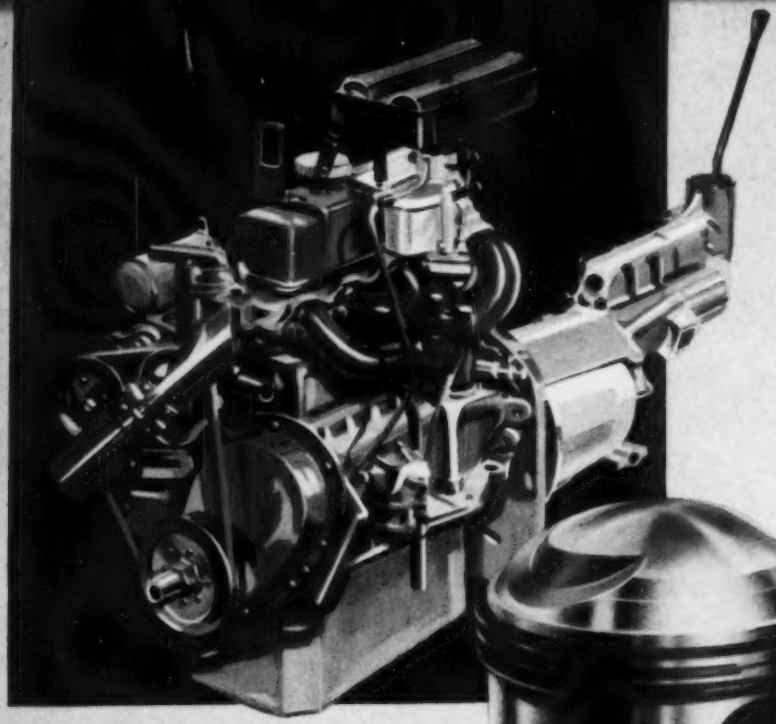

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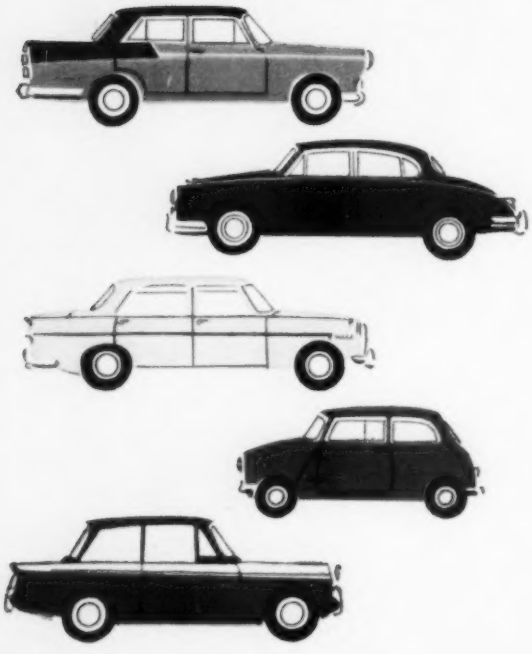

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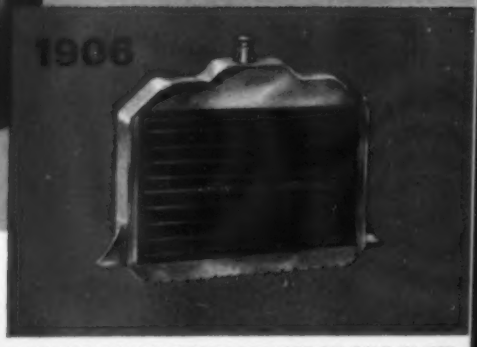

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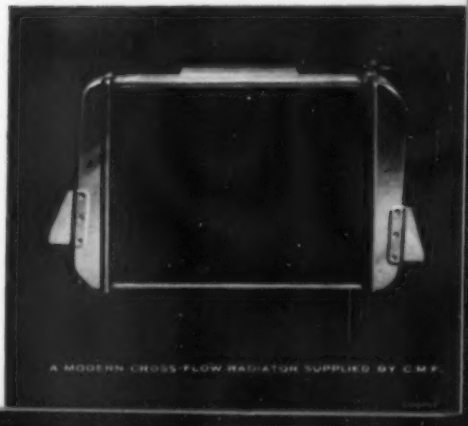

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AUTOMOBILE ENGINEER

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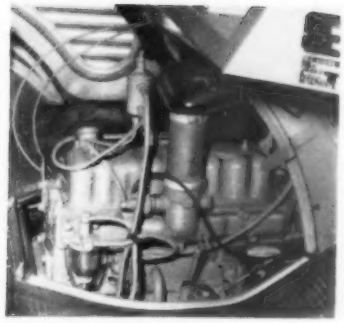

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AUTOMOBILE ENGINEER

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Background to Reliability

DURING an informal discussion held recently at the Institution of Mechanical Engineers, evidence was produced of the correlation between the complexity and the unreliability of various types of equipment. The fact of this correlation is not in itself remarkable: most engineers become aware of it early in their careers. However, the evidence was noteworthy in one respect: there was a wide scatter in the graphical plots of complexity against unreliability of comparable products.

Analysis of these results revealed that the products of one particular company had proved far more reliable in service than those from other firms. This superiority was attributed to the existence of a strong team spirit in the organization concerned, a spirit that permeated from the management right down to the shop floor. The project under consideration had presented a major challenge, which was worthily met at all levels. Obviously, there is food for thought here for the automobile industry.

Recently, complaints have been voiced of unreliability, especially in relation to the delivery of new cars in defective condition, but also, in certain instances, of failure of vehicles to withstand arduous but not unreasonable service conditions. This indicates that the problem concerns both production and design departments. In seeking the remedy, it would be short-sighted to confine attention simply to the rectification of the current situation, for complexity inevitably will increase, for example, as automatic transmission systems come into more general use. A much deeper study of many aspects of design and manufacture is needed.

There has, perhaps, been a tendency to overlook the fact that the attainment and maintenance of high qualitative standards necessary to ensure reliability still depend mainly on the human factors. It is notoriously difficult in a large organization to inculcate an effective team spirit at all levels; nevertheless, probably the most pressing requirement is improvement in the general attitude to their work of all personnel, but especially those not subject to the spur of major responsibility.

Very large firms, of course, need not regard the difficulties, arising from their size, as insuperable. Much can be done by dividing into small, largely self-contained units, each specializing in a particular branch of the work. The advantages of this measure include better control, by virtue of decentralization, closer personal contacts and the avoidance of the feeling by each individual that he is an insignificant part of a vast machine. Decentralization does, of course, introduce other problems beyond the scope of this short article.

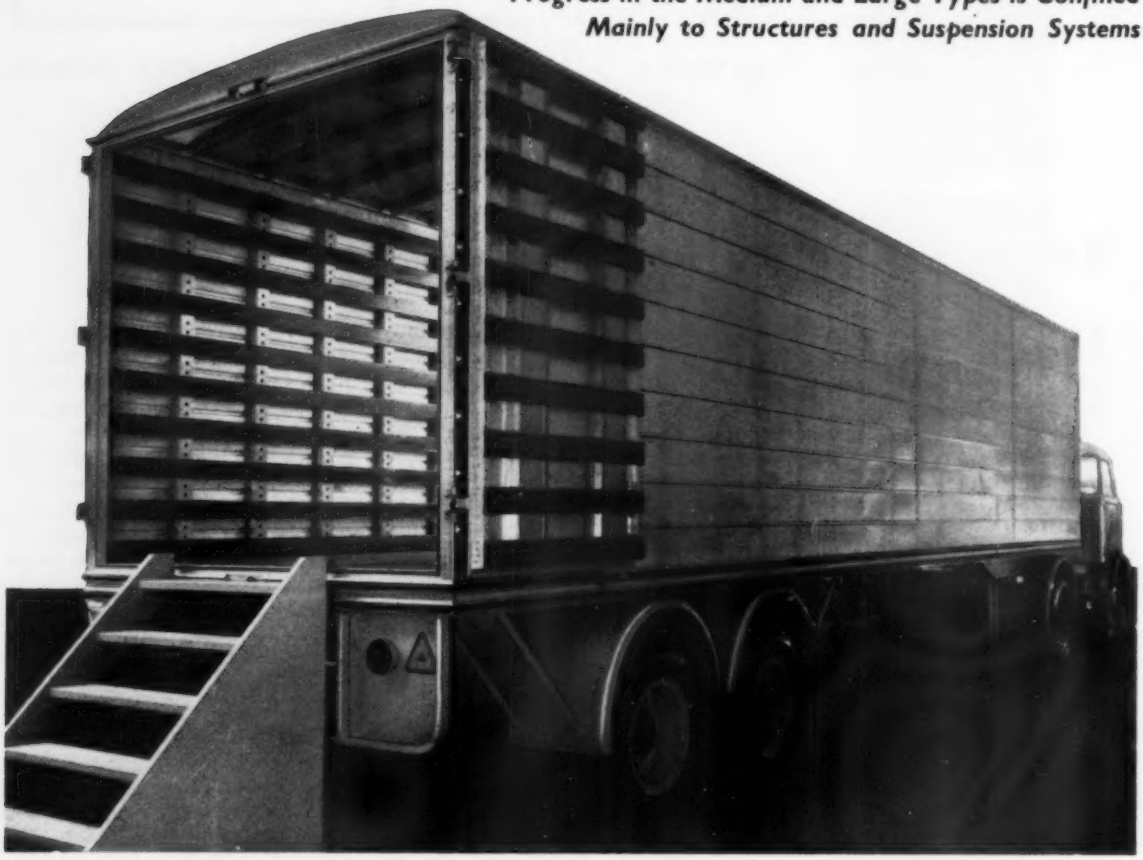
As is well known, it is at shop floor level that the difficulties are most pronounced. Probably the main factor in this is the marked reduction in individual responsibility that has been effected by current manufacturing techniques. The problem is two-fold, since both the making of components and their assembly are involved. Regarding the first of these aspects, means of achieving improved quality were discussed in the leading article in the August 1958 issue of *Automobile Engineer*. These methods, however, involving checks by the personnel on the work they themselves are performing, are not entirely applicable to the assembly shops, where a raising of the general standard is required at least as much as in the machine shops.

Of itself, the frequent repetition of relatively insignificant assembly tasks can hardly be expected to be conducive to pride or satisfaction. Nevertheless, some system must be found of improving human efficiency in these circumstances. At this stage, the issue is one for the industrial psychologists rather than the quality controllers. Fundamental research is needed on the whole question of motives and incentives for employees engaged on repetition jobs. In this connection, there are indications that the prospect of financial reward is not necessarily the strongest incentive towards the attainment of better quality: among other factors that must be considered are personal prestige—both with workmates and in the domestic and social situations—and the relationship with immediate superiors.

Some research on these lines has already been undertaken, but the investigators have usually encountered a serious difficulty: the problems can be studied effectively only on the shop floor and, since this study inevitably interferes with production, managements are naturally loth for it to be undertaken. However, there are certain basic principles of industrial psychology that can be applied in any factory without marked dislocation of the work. The first is that adequate care should be taken in the selection, placing and training of employees to ensure the maximum potential efficiency. Secondly, working conditions and methods should, of course, be as congenial as possible—this is a constant challenge, for the ultimate never will be attained—and finally, the quality of the supervision should be high.

Continental Commercial Vehicles

Progress in the Medium and Large Types is Confined Mainly to Structures and Suspension Systems



Typical of current Continental thought on box semi-trailers is the D.A.F. Eurotrailer, which is of integral construction and has a light alloy body

IN dealing primarily with commercial vehicles of medium size and above, this article is intended to be complementary to that in the March 1960 issue of *Automobile Engineer*, in which the lighter types were surveyed. Clearly, the subject is too extensive for each manufacturer's models to be covered in detail. In consequence, a representative selection of the more interesting vehicles has been made, with a view to providing a guide to Continental practice in the various categories. Since the German products in this field were dealt with in our November 1959 issue, coverage of that country's vehicles will be confined to more recent developments of interest.

A study of current Continental designs reveals several trends. Probably the most important of these is the increasing adoption of integral construction for large semi-trailers and trailers of the box transporter type. These vehicles, which, in European countries, are known as international transporters, have been evolved to meet the needs of firms specializing in long-distance bulk haulage. Such duties can, and often do, involve journeys of 500 miles and more, and it is clearly most desirable for the ratio of structural weight : all-up weight to be low. As in the case of private cars, the integration of chassis and body makes possible a higher structural efficiency than can be obtained when separate assemblies are bolted together.

Although there are examples of unitary construction among the lighter of the medium range of vehicles—those with a payload of 1 to 2 tons—most manufacturers of this class remain faithful to the concept of a separate chassis and body. The reason for this is not hard to find. Chassisless construction of the conventional all-welded type involving the use of pressings is, by its nature, suitable only for large-scale production; where a manufacturer offers several body variants, they must all be made in relatively large quantities and must embody the maximum number of common components. Although the medium-size vehicles are made in considerably smaller numbers than are those of below about 1 ton payload, the variety of possible uses for them is nearly as great. It follows that if unitary construction is to be employed the manufacturer must be prepared to sacrifice a marginal part of the potential market by concentrating on only one or two body styles.

On the Continent, as in Britain, intensive efforts have been made recently to improve suspension systems. In general, these activities are directed along channels similar to our own. One of the main objectives is, of course, to improve the ride in

the unladen condition without detracting from the ability of the suspension to cope with full loads. It is now widely appreciated that a system that works well with the vehicle unladen confers substantial benefits other than the improvement in the comfort of the crew. The risk of fatigue failure of components is lessened and tyre life and braking efficiency are markedly improved because of the reduced amount of wheel bounce.

Of the various methods adopted to improve the suspension, the simplest is the use of small hollow rubber springs to supplement leaf springs of orthodox design. These auxiliary springs are usually of the double-convolution type similar to the Aeon units described in the April 1958 issue of *Automobile Engineer*, and there are examples of their being mounted both on the chassis frame and on the main spring. The positioning is such that, as in the case of a conventional helper spring, the units become effective beyond a certain bump deflection of the axle. Since the auxiliary springs themselves have non-linear load-deflection characteristics, there is a progressive rise in the effective rate of the suspension beyond their take-over point.

It is significant that on the Continent, as in Britain and the U.S.A, enthusiasm for air suspension—so pronounced a few years ago—has now been tempered with a modicum of reserve. This comment must not be assumed to imply that this type of suspension has no future on commercial vehicles. On the contrary, it is in this field that its prospects are brightest, but the former over-optimism has given way to realistic appraisal. Designers are now aware that air suspension cannot be regarded as a universal panacea, and that it poses its own particular problems. It has to be applied with considerable care if it is to show the advantages, over metal springs, that have so long been claimed for it.

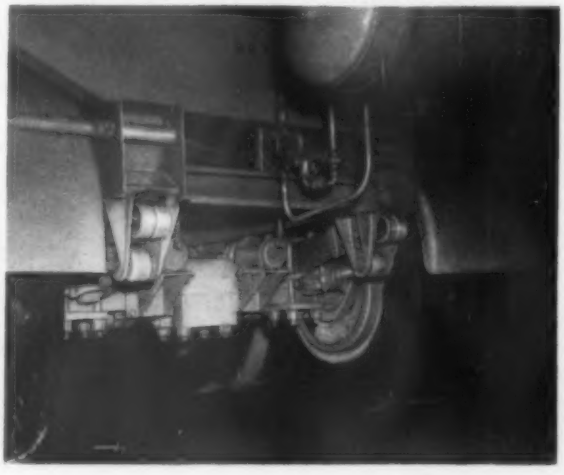
Regarding the vehicles studied in the preparation of this review, the only examples of what might be termed pure air suspension were found on large semi-trailers—there were none on truck or tractor chassis. On certain coaches and public service vehicles, air forms the sole suspension medium but, in general, these categories are outside the scope of this article. The more popular system for other self-propelled vehicles is that in which air springs are used in conjunction with semi-elliptic leaf springs. In effect, the leaf springs support the unladen weight of the vehicle, and the air springs serve to provide an increase of rate with load, while maintaining a constant chassis height from the ground. This system, though it involves the use of two suspension media, has two obvious advantages over a layout for air springs only: it provides a simple and well understood method of locating the axle, and it simplifies the conversion of an existing leaf spring layout.

In the U.S.A. commercial vehicle manufacturers are tending to adopt independent front suspension on even quite large chassis, and—as was indicated in last year's article—the European builders employ it widely on their smaller models. However, there is as yet little sign on the Continent of much interest in the independent type of layout for vehicles of over about 2 tons payload. This lack of enthusiasm may seem surprising in view of the long distances and relatively high cruising speeds that are commonplace on the European mainland. An additional advantage of an independent suspension system is that it permits the adoption of a lower engine installation, thereby conferring greater stability and, in the case of vehicles without forward control, an improved field of vision for the driver.

It would appear that most manufacturers of the larger types of vehicle consider that the greater cost and complexity of an independent system more than outweigh its advantages. The complexity is not, of course, confined to the suspension itself: because of the nature of the dynamic loading involved, the vehicle structure has to be more torsionally rigid than where a beam axle is employed. Whereas the necessary stiffness is relatively easy to obtain with a unitary structure, its embodiment in a frame with conventional side members of channel section is more difficult.

Few developments of any significance have taken place in the design of chassis frames, nor is it easy to see where any fundamental improvement could be effected. However, there are instances of the use of a higher grade of steel than usual for the main members. Although the material cost per unit of weight is increased by this change, the thickness of the section can be reduced; thus, the cost of the structure is not substantially increased, while its weight is appreciably reduced, with benefit in respect of the payload.

At present, engine design is in a rather static condition, in that the majority of manufacturers have evolved power units of sufficient performance and reliability for present-day operational requirements. A few years ago it seemed that, both in Britain and on the Continent, the turbocharger was going to become very popular as a means of increasing the power output and torque of diesel engines. On both sides of the Channel, though, the last year has not shown any further marked advance in this direction. To judge by catalogue figures, specific outputs and fuel consumptions are at much the same level as those of British engines. Interest



Two of the leaf spring suspension layouts that are employed on Titan semi-trailers. In each case, both ends of the springs are free to slide, and the axle is located by trailing links; in the single-axle layout illustrated above, the links are situated above the springs

in the small high-speed diesel engine continues at a high level, although no significant new designs have recently been introduced.

There is little novelty, too, in the realms of transmissions and final drives. While automatic and semi-automatic transmission systems are becoming increasingly popular for buses and coaches, the manually controlled gearbox remains firmly established in the specification of commercial vehicles. As an indication of the increasing attention being paid to the comfort and convenience of the driver, however, servo assistance for the gear change is finding increasing favour. There is a continuation of the tendency, found also in this country, towards the provision of a larger number of ratios, and synchromesh engagement of all gears is featured on some of the more expensive vehicles.

So far, the Continental manufacturers have not adopted glass reinforced polyester resin to the extent that now applies in Britain. As is well known, several of our commercial vehicles builders offer complete cabs made of this material, sometimes optionally in place of a metal cab, and it is also used for wings and for frontal and roof panels. It is noteworthy that British plastics cabs have a better appearance than do the majority of products from the European factories, so it will be surprising if competitors in the world's markets do not rapidly acquire a greater appreciation of the merits of polyester-glass for relatively small-scale production runs.

With reference to the earlier mention of driver comfort, there is no doubt that the treatment of the cab interior has reached a considerably higher level of refinement on the Continent than in Britain, at least as far as heavy commercial vehicles are concerned. This superiority does not lie merely in the widespread provision of adjustment of the height and rake of the seating, but also in the comfort of the cushions and squabs, and in the trimming and the provision of amenities. The trim, in most instances, is pleasant to look at as well as functional, heat and noise from the engine compartment are effectively excluded, and care has been lavished on the draught sealing, ventilating and heating arrangements.

In considering this difference between British and Continental practice, it must not be forgotten that the operating conditions in the two areas are not directly comparable. Across the Channel, hauls are frequently considerably longer than here, so a crew spends more time between lengthy breaks in the cab. Moreover, in some areas the road surface is probably, in general, less smooth; hence, a higher level of seating comfort is necessary to avoid soreness and excessive fatigue. On the other hand, the traffic density in Britain is generally higher and there are fewer stretches of road on which the driver can relax his concentration to any extent. It is therefore not unreasonable to suggest that our own manufacturers should reconsider the amenities for vehicle crews, with a view to bringing them more in line with the best Continental practice.

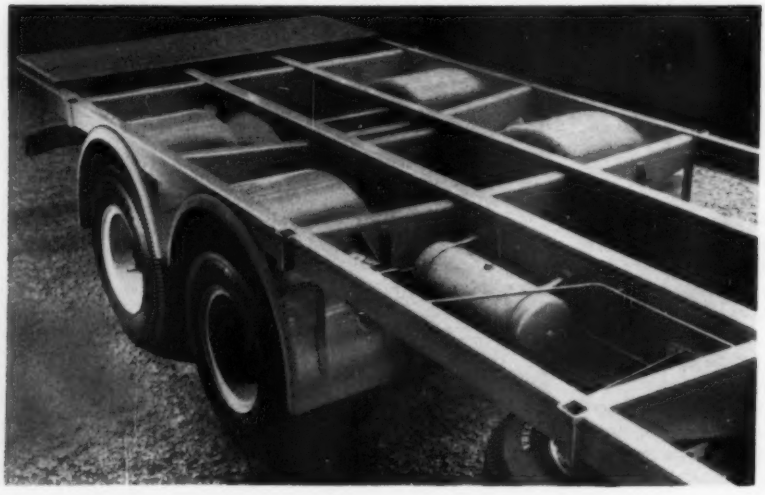
Semi-trailers and trailers

One of the most noteworthy of the new box transporters of integral construction is the D.A.F. type ELT3224, known as the Eurotrailer, which is 36 ft long. It consists basically of a steel underframe structure, a wooden floor and an aluminium and light alloy superstructure. The underframe portion is of the ladder pattern, comprising side rails of channel section and no fewer than 21 cross members. At the rear, the side rails are bridged by a welded-on sub-frame, of deep channel section, which carries the tandem axle suspension; the structure is reinforced at the front to take the fifth wheel. Between the sub-frame and the fifth wheel, the lipped channel section of the cross members is deepened for about three-quarters of the span, to provide the necessary resistance to bending.

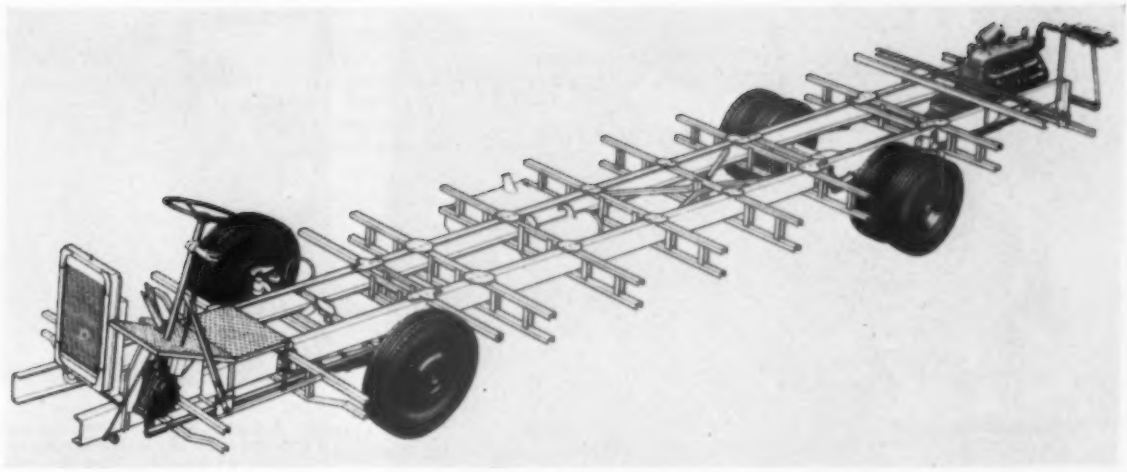
The vertical ribs of the body sides, which are in the same planes as the cross members, are riveted to the side rails. These ribs are of light alloy and each consists of a top hat section closed by a perforated strip; the perforations provide access for attaching the skin panels to the ribs. Each roof cant rail comprises two light alloy extrusions, riveted to each other and to the side and roof ribs. The extrusions are of different depths but both have a section approximating to an inverted letter J, without a bar. Extrusions of Z section form the roof sticks, which have a shallow curvature.

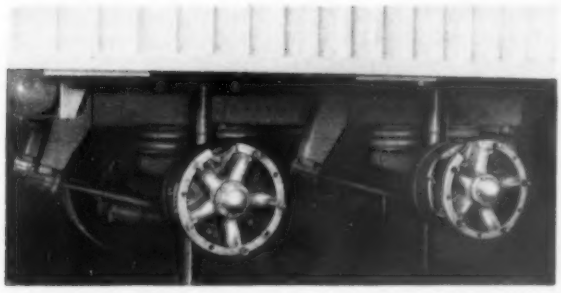
Aluminium sheet is employed for the sides and most of the roof. The side panels have small, horizontal corrugations of channel section, spaced about 9 in apart. Each panel spans five ribs and is attached by riveting. The roof panels are of uncorrugated sheet, also riveted in position. Unpigmented, glass reinforced polyester resin is used for the front and rear domed ends of the roof, and for the section of it comprising bays 2 to 5. If desired, longitudinal wooden slats can be fitted to the interior of the body sides and the rear doors.

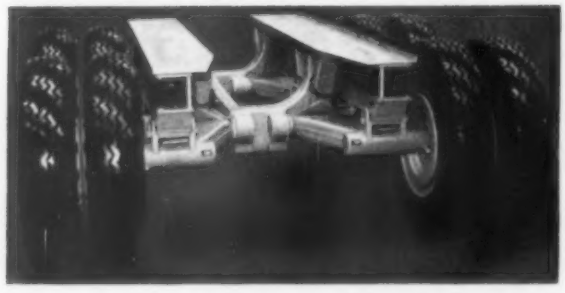
Alternatives of leaf spring and air suspension are available. In the case of the leaf springing, a simple layout is employed, in which a semi-elliptic spring is clamped at the middle to a deep box bracket welded to the underside of each side member



The D.A.F. LT3200 semi-trailer chassis is a robust and well engineered design. Its two main longitudinal members, which are of a high-grade steel, have an unusually deep channel section, and the outrigged side rails run the length of the chassis







Top: The Brossel 90DAR underframe unit, intended for integration with a single-deck bus body, is said to be remarkably light; a Leyland Power-Plus S.400 engine, of 6·54 litres, is mounted at the rear. The two lower views show contrasting ideas on air suspension for semi-trailers: on the left is the system employed on the Fruehauf box transporter, and the other is optionally available on two D.A.F. models, the Eurotrailer and the LT3200

of the suspension sub-frame. The two box brackets, which are of fabricated construction, are braced to each other by light transverse diagonal members. Each end of each spring is clamped to one of the two beam axles. Twin wheels are carried on each axle and are fitted with 9·00—20 in tyres.

The air suspension system is of the independent trailing arm type, in which the arms provide both longitudinal and lateral location of the wheels. All four arms are of identical basic design, and are fabricated from pressings; they have a wide, rectangular cross section, tapering in width towards the welded-on stub axle tube at the rear. The leading end of each arm pivots in two well spaced plain bearings housed on the rear face of a box section transverse member. These two transverse members are carried below the suspension sub-frame by fabricated brackets of trident formation, with box section prongs, and are bridged medially by a longitudinal member.

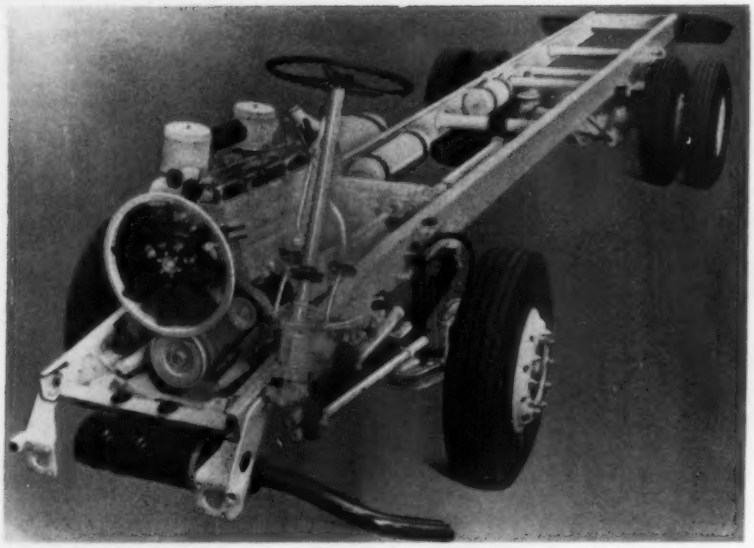
Two air springs are employed. They are of the long, double-convolution pillow type, made in America by the General Tyre and Rubber Co. The upper abutment of each is a longitudinal platform attached to the sub-frame, and the lower one is another platform bridging the stub axles. To allow for the relative longitudinal movement that can occur between the axles on one side, the lower platform has a sliding attachment to the axles. This is a robust and well engineered suspension system but, since there is no leverage ratio between the wheels and the air springs, bump travel would appear to be limited to about 3 in.

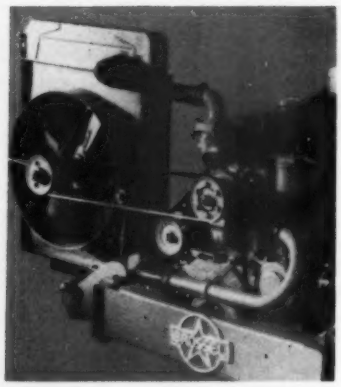
The ELT3224 semi-trailer has an interior width and height of approximately 7 ft 7 in and 7 ft 5 in respectively, and its effective interior volume is 55m³, or 1,940 ft³. Its unladen weight is quoted as just under 5 British tons, and the all-up weight as 25½ tons, of which about 62 per cent is carried by the rear wheels.

Two other D.A.F. products worthy of mention are the LT3200 semi-trailer and the LVW1616 trailer. The first of these is 35 ft long and has the same all-up weight as the box transporter. Its all-welded chassis frame is of very robust construction and incorporates two deep, channel section longitudinal members of high-grade steel, set fairly close together and reinforced at the swan-neck bend near the front. To provide a solid basis for the body, there is a continuous, outrigged channel section rail at each side. The outriggers carrying these rails are of tapering depth and channel section, and they form extensions of the main cross members.

This semi-trailer is fitted in its standard form with a leaf spring suspension system similar to that already described. Two additional cross members are fitted, between the main longitudinals only, to reinforce the frame in the region of the suspension box brackets. The wheel and tyre equipment is identical with that of the Eurotrailer.

In the case of the LVW1616 trailer, the chassis frame construction follows the same general lines as on the LT3200, apart from the obvious differences necessitated by the fact that there is a front axle and not a fifth wheel. Both axles are of the beam type, and each is fitted with paired wheels having 9·00—20 in tyres. The trailer is supported on semi-elliptic springs, which have the conventional type of eye at the leading end, and a sliding anchorage at the rear.





Left: A chassis of straightforward design is employed on the new Brossel Europ range of commercial vehicles. There are light, medium and heavy versions, all of which are fitted with Leyland engines. Above: On one of the Brossel coach chassis, this offset radiator and pusher fan layout is employed

This trailer is 24 ft long and its all-up weight is 15·7 tons.

Three other firms manufacturing large box semi-trailers of integral construction are Fruehauf and Titan, both French concerns, and the Belgian T.T.A. company which, incidentally, originated in England. The Fruehauf vehicle is built mainly of steel—including the body sides—and is based on a ladder type underframe unit. Channel section material is employed for the side rails and most of the cross members, but inverted top hat transverse bracing is used at the mounting for the fifth wheel. In contrast to the D.A.F. model, the Fruehauf vehicle has vertically corrugated body side panels. As one of the accompanying illustrations shows, the corrugations are relatively deep and closely spaced, to avoid the need of any internal supporting structure, except at the corners.

The rear suspension sub-frame has the plan form of a rectangle; the long sides of the rectangle are longitudinal and are bisected by a transverse bridge member. These three members are of box section, and the two ends of the rectangle have a channel section. An air suspension system is employed for the tandem axles: it is stated to be of U.S.A. design and embodies several unusual features. Each axle is of the beam type and carries a fabricated platform at each end. Interposed between each platform and the sub-frame are two Dunlop double-convolution air springs and a telescopic damper.

Longitudinal location of each axle is effected by a pair of spring steel trailing links of tapering, rectangular section. The thick end of the link is clamped to the axle and its thin end to a box section bracket projecting downward and slightly forward from the sub-frame longitudinal member. Lateral location is effected by means of a panhard rod. One pair of Westinghouse levelling valves is employed, actuated by vertical rods interconnecting them with the rearmost axle. This vehicle is 35 ft long, has an unladen weight of 6 metric tons, and its capacity is 55m³.

Several Titan semi-trailers in this category are available, of which the largest is comparable with the D.A.F. and Fruehauf products; it has a tandem axle bogie and is of steel construction. Here again, a ladder type underframe unit is employed, consisting of channel section side rails and a considerable number of cross members, the majority of which are of a lipped channel section. However, those carrying the welded-on sub-frame for the rear suspension are not lipped but are of a greater depth than the others over most of their span, as also are those to which the supporting legs are attached.

The sub-frame comprises two longitudinal beams braced by transverse members. These beams are of closed top hat section, and to them are anchored the four semi-elliptic springs, which have a sliding mounting at each end. The two axles are of square section and are rigidly connected by a longitudinal member; over most of the portion between the axles, this member is in the form of two box section beams spaced apart, one above the other, but web plates unite the two at each end. Longitudinal location of the axle assembly is effected by means of two pairs of short, longitudinal trailing links; two interconnect each axle and the front anchorage bracket of the appropriate spring, below the spring.

In its construction, the body closely resembles that of the Fruehauf semi-trailer, in that vertically corrugated side panels, riveted to the side rails, are employed. One version has a detachable fabric top, resting on transverse roof sticks spaced about 4 ft apart—a feature that should facilitate the loading and unloading of certain types of goods. The all-up weight is the same as that of the D.A.F. Eurotrailer but the load capacity is slightly lower, at 19·7 tons.

Other semi-trailers in the Titan range have bodies of light alloy instead of steel, and in these, too, the panels have deep, vertical corrugations. The suspension layout of those with a single axle resembles the tandem axle design in that both ends of the spring are free to slide; however, the trailing links for longitudinal location are mounted above the springs instead of below them.

In the T.T.A. semi-trailer, more light alloy is used than in those already described, since both the body and the underframe side rails are made of this material. For the side rails an extruded section is employed, which can best be described as an inverted T, of which the upper part of the leg is turned inward and the tips of the arms are turned downward. The cross members and the rectangular sub-frame for the suspension are steel; the former are riveted to the side rails, whereas the sub-frame is welded to the appropriate cross members. Additional welded-on members transmit longitudinal dynamic loadings from the sub-frame to the cross members immediately in front of and behind it.

The spring units of the suspension system are of a similar

type to those of the D.A.F. Eurotrailer, but there is no other resemblance. On the T.T.A. layout, beam axles are used, and they are connected at each side by a platform on which is mounted the lower abutment of the air pillow. The upper abutments are on the longitudinal members of the sub-frame. Projecting forward from the middle of each axle is a box bracket of approximately pyramidal shape. At its apex is a short spindle, which carries the inner sleeve of a large-diameter rubber bearing, of the bonded type. The housing of this bearing is attached to a cross member of the sub-frame. This method of wheel location is robust, neat and less costly than some, and the amount of lateral or longitudinal float permitted by the rubber bearings should be insufficient to have any harmful effect on the handling characteristics of the vehicle.

Heavy tractors and lorries

An interesting new range of heavy vehicles is the Brossel Europ forward-control series, introduced in Belgium specifically to meet the proposed transport regulations of the European Common Market. For some years Brossel Frères, which looks after Leyland and Albion interests in Belgium, has been employing Leyland engines and, more recently, transmission units in its products. Consequently, this company is the first outside the Leyland group to be supplied by it with the new Power-Plus engines, which are installed in all the Europ models.

There are three groups in the range—light, medium and heavy—and each comprises a series of vehicles with a choice of the same five wheelbases. In fact, as a result of careful rationalization of the design, many of the chassis components are common to all three groups. The wheelbases are 9 ft 10 in, 11 ft 6 in, 13 ft 1½ in, 15 ft 1 in and 17 ft 1 in, and the vehicle types offered include tractors, tippers and trucks. There is a sub-division into A and B classes in the light group, the all-up weights of which are respectively 12 and 16 metric tons. This second figure applies also to the medium group and to class C vehicles in the heavy group; class D vehicles in this third group have an all-up weight of 19 tons.

In the case of the lightest group, the engine is the 6·54 litre S.400 unit producing 125 b.h.p. at 2,400 r.p.m; the medium group has the 9·8 litre O.600 engine, of 150 b.h.p. at 2,200 r.p.m, while the heavy-duty series is equipped with the 11·1 litre O.680 engine, of which the output is 200 b.h.p. at 2,200 r.p.m. For the present, all models will have proprietary gearbox and final-drive assemblies, but it is envisaged that transmissions will eventually be manufactured in Belgium. For all three groups, the present standard final-drive units are taken from the Leyland-Albion range and are of the double-reduction type, with an epicyclic secondary reduction in the hubs. A two-speed axle, with electrically operated ratio-change mechanism, is available as an option on light group models.

Leyland gearboxes are installed on the vehicles in the light and heavy groups. For the first of these, a five-speed unit has been adopted, but it can be fitted with an overdrive sixth ratio if desired. These alternatives are available also on the heavy-duty models, with the optional addition of a crawler ratio. On the medium group, a ZF six-speed gearbox, with synchromesh engagement of all forward ratios, is specified.

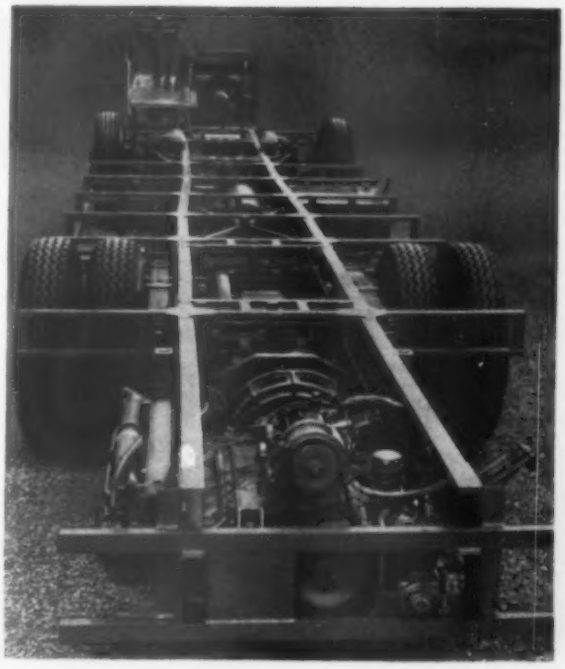
The chassis of these vehicles are largely of orthodox design. Parallel side members are employed, which have a slight downsweep and a taper in depth at their leading ends. The depth and thickness of the section varies with the load rating of the vehicle, but the maxima and minima are 12 in × $\frac{5}{16}$ in and 9 in × $\frac{1}{4}$ in. All the intermediate cross members between the gearbox bearer and the channel section rear cross member are of tubular construction, with welded-on flanges at the ends, and are bolted to the side members.

A conventional suspension system, with long semi-elliptic springs, has been adopted, and the action of the front springs is controlled by telescopic dampers. The steering gear is of the cam and double roller type, and power assistance is an optional extra. This assistance is effected by a hydraulic jack acting on the drop arm; the control valve unit is housed on the lower end of the box.

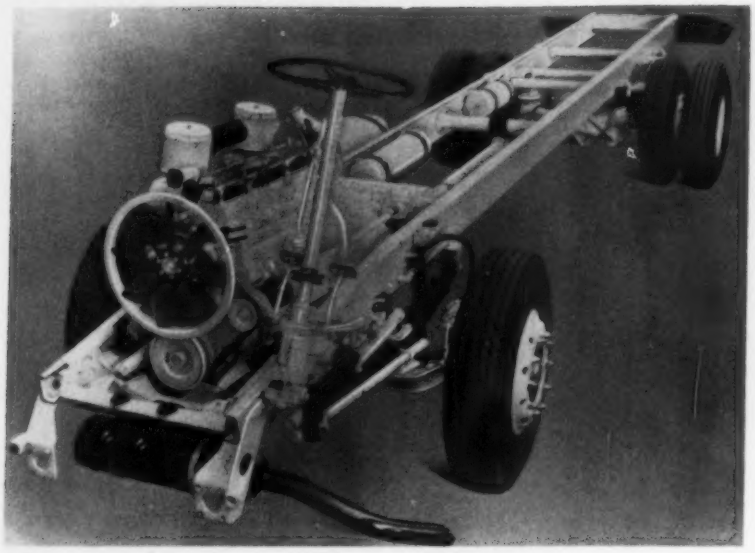
On the class A vehicles in the light group, an air-assisted braking system is employed. All the other models have direct air actuation by means of a diaphragm unit for each brake drum. A commendable feature is that the handbrake has air assistance. The compressor is directly driven, from the timing train, in the conventional manner.

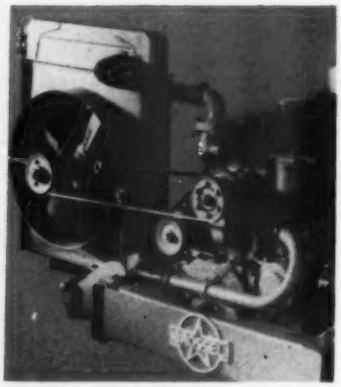
In contrast to the majority of Continental commercial vehicles, the Brossel Europ models have cabs of polyester-glass. Although these cabs bear a marked resemblance to those currently fitted to Leyland and Albion vehicles, only the sturdy steel framework comes from Britain, the mouldings being produced in Belgium. The front wings are integral with the cab, which embodies paired headlamps. There are corner windows in the rounded quarters, in addition to the

The cab of the Brossel Europ models is made of polyester-glass on a steel frame supplied by the Leyland group



A Leyland O.680 unit is installed under the floor at the rear of the Brossel 103DAR bus chassis. The method of frame construction is similar to that used for the 90DAR model illustrated elsewhere





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In the T.T.A. semi-trailer, more light alloy is used than in those already described, since both the body and the underframe side rails are made of this material. For the side rails an extruded section is employed, which can best be described as an inverted T, of which the upper part of the leg is turned inward and the tips of the arms are turned downward. The cross members and the rectangular sub-frame for the suspension are steel; the former are riveted to the side rails, whereas the sub-frame is welded to the appropriate cross members. Additional welded-on members transmit longitudinal dynamic loadings from the sub-frame to the cross members immediately in front of and behind it.

The spring units of the suspension system are of a similar

type to those of the D.A.F. Eurotrailer, but there is no other resemblance. On the T.T.A. layout, beam axles are used, and they are connected at each side by a platform on which is mounted the lower abutment of the air pillow. The upper abutments are on the longitudinal members of the sub-frame. Projecting forward from the middle of each axle is a box bracket of approximately pyramidal shape. At its apex is a short spindle, which carries the inner sleeve of a large-diameter rubber bearing, of the bonded type. The housing of this bearing is attached to a cross member of the sub-frame. This method of wheel location is robust, neat and less costly than some, and the amount of lateral or longitudinal float permitted by the rubber bearings should be insufficient to have any harmful effect on the handling characteristics of the vehicle.

Heavy tractors and lorries

An interesting new range of heavy vehicles is the Brossel Europ forward-control series, introduced in Belgium specifically to meet the proposed transport regulations of the European Common Market. For some years Brossel Frères, which looks after Leyland and Albion interests in Belgium, has been employing Leyland engines and, more recently, transmission units in its products. Consequently, this company is the first outside the Leyland group to be supplied by it with the new Power-Plus engines, which are installed in all the Europ models.

There are three groups in the range—light, medium and heavy—and each comprises a series of vehicles with a choice of the same five wheelbases. In fact, as a result of careful rationalization of the design, many of the chassis components are common to all three groups. The wheelbases are 9 ft 10 in, 11 ft 6 in, 13 ft 1½ in, 15 ft 1 in and 17 ft 1 in, and the vehicle types offered include tractors, tippers and trucks. There is a sub-division into A and B classes in the light group, the all-up weights of which are respectively 12 and 16 metric tons. This second figure applies also to the medium group and to class C vehicles in the heavy group; class D vehicles in this third group have an all-up weight of 19 tons.

In the case of the lightest group, the engine is the 6·54 litre S.400 unit producing 125 b.h.p. at 2,400 r.p.m; the medium group has the 9·8 litre O.600 engine, of 150 b.h.p. at 2,200 r.p.m, while the heavy-duty series is equipped with the 11·1 litre O.680 engine, of which the output is 200 b.h.p. at 2,200 r.p.m. For the present, all models will have proprietary gearbox and final-drive assemblies, but it is envisaged that transmissions will eventually be manufactured in Belgium. For all three groups, the present standard final-drive units are taken from the Leyland-Albion range and are of the double-reduction type, with an epicyclic secondary reduction in the hubs. A two-speed axle, with electrically operated ratio-change mechanism, is available as an option on light group models.

Leyland gearboxes are installed on the vehicles in the light and heavy groups. For the first of these, a five-speed unit has been adopted, but it can be fitted with an overdrive sixth ratio if desired. These alternatives are available also on the heavy-duty models, with the optional addition of a crawler ratio. On the medium group, a ZF six-speed gearbox, with synchromesh engagement of all forward ratios, is specified.

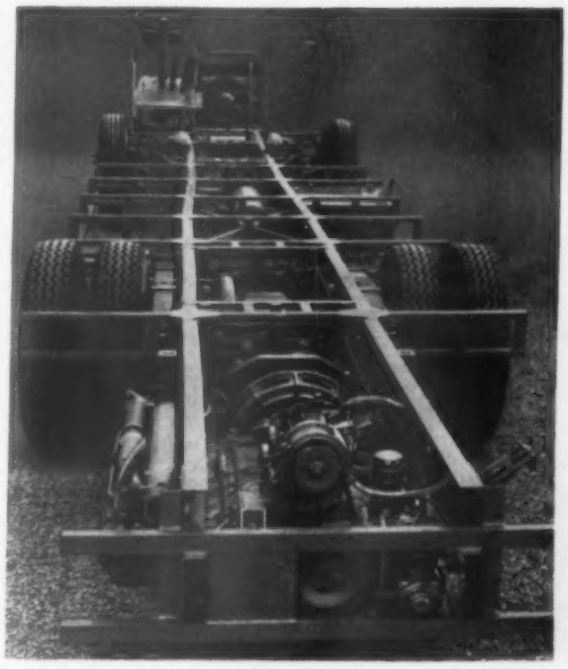
The chassis of these vehicles are largely of orthodox design. Parallel side members are employed, which have a slight downsweep and a taper in depth at their leading ends. The depth and thickness of the section varies with the load rating of the vehicle, but the maxima and minima are 12 in × $\frac{5}{16}$ in and 9 in × $\frac{1}{4}$ in. All the intermediate cross members between the gearbox bearer and the channel section rear cross member are of tubular construction, with welded-on flanges at the ends, and are bolted to the side members.

A conventional suspension system, with long semi-elliptic springs, has been adopted, and the action of the front springs is controlled by telescopic dampers. The steering gear is of the cam and double roller type, and power assistance is an optional extra. This assistance is effected by a hydraulic jack acting on the drop arm; the control valve unit is housed on the lower end of the box.

On the class A vehicles in the light group, an air-assisted braking system is employed. All the other models have direct air actuation by means of a diaphragm unit for each brake drum. A commendable feature is that the handbrake has air assistance. The compressor is directly driven, from the timing train, in the conventional manner.

In contrast to the majority of Continental commercial vehicles, the Brossel Europ models have cabs of polyester-glass. Although these cabs bear a marked resemblance to those currently fitted to Leyland and Albion vehicles, only the sturdy steel framework comes from Britain, the mouldings being produced in Belgium. The front wings are integral with the cab, which embodies paired headlamps. There are corner windows in the rounded quarters, in addition to the

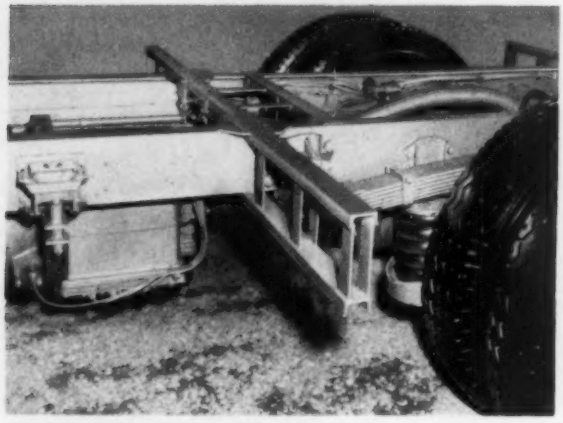
The cab of the Brossel Europ models is made of polyester-glass on a steel frame supplied by the Leyland group

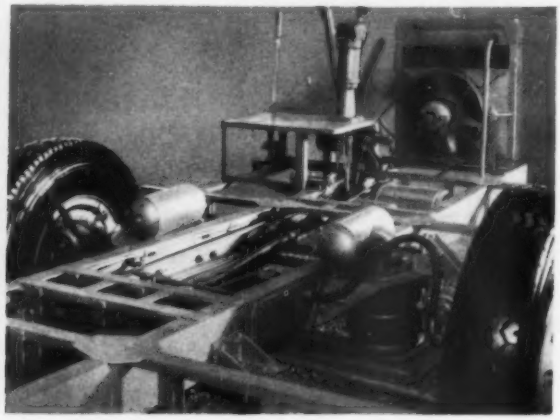


A Leyland O.680 unit is installed under the floor at the rear of the Brossel 103DAR bus chassis. The method of frame construction is similar to that used for the 90DAR model illustrated elsewhere

normal rear light, and the curved windscreen has an appreciable degree of wrap-round. Included in the list of standard equipment are a heater and defroster unit, twin mirrors, a windscreen washer, an interior light with door-actuated switch, and an external sun visor, as well as a cigar lighter, ash tray, map pocket and coat hanger.

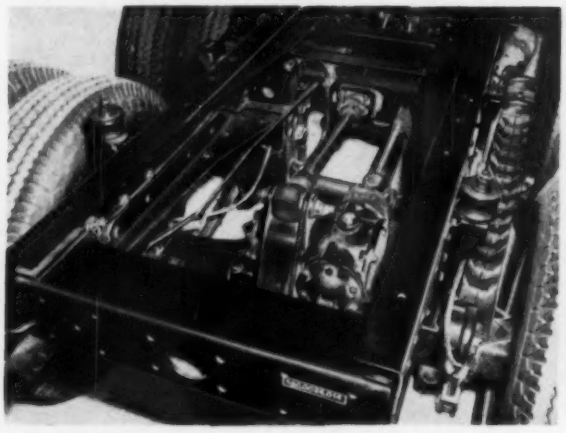
Because of Brossel's use of British engines as standard equipment, it is perhaps appropriate to mention certain details of bus and coach chassis manufactured by this company, since these are of considerable technical interest. The latest of these is the 90DAR model, which is not a chassis as normally understood, but is an underframe unit—complete with engine and transmission—for integration with a single-deck body. For city services, the passenger capacity can be as high as 80, of which a considerable number has to stand. A Leyland Power-Plus S.400 engine is installed



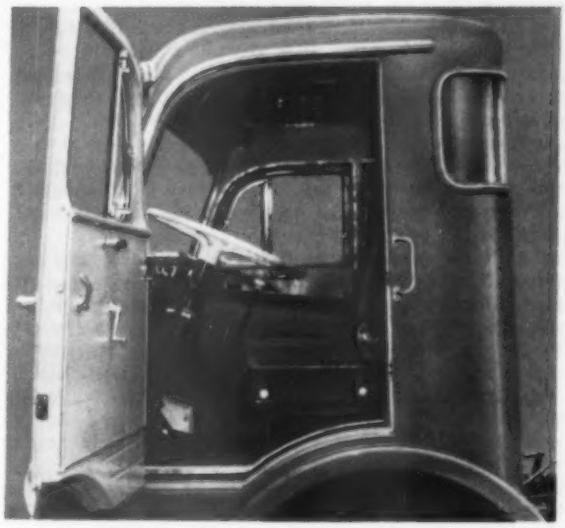


Above: A combination of air and leaf spring suspension is employed for both axles of the Brossel 103DAR chassis. At the rear, twin air springs are situated below each of the negative-camber leaf springs; the leaf springs of the front suspension are below the axle. The radiator fan seen in the right-hand view is electrically driven, and a thermostatic switch is incorporated

Right: The Fiat 690 models are among the few Continental heavy commercial vehicles that have tandem front axles. Below right: a view of the Fiat 690 front suspension, showing part of the steering linkage, to which power assistance is applied. Below left: The rear suspension of the Magirus-Deutz Saturn 195FS tractor comprises two inverted semi-elliptic springs, pivoted on the frame, and six longitudinal links, three of which control each of the axles



Above: On the Mercedes-Benz LPS333 six-wheel tractor, the trailing front axle is mounted well behind the middle of the wheelbase, a feature that necessitates a complex steering linkage. The cab of this vehicle, seen on the right, is finished internally to a remarkably high standard



vertically at the extreme rear, and drives forward to the axle through a fully automatic transmission incorporating the familiar Leyland torque converter.

The all-welded underframe structure is based on two straight, channel section longitudinal members and a system of light but strong cross bracings. Each transverse member consists of two inverted channel sections, welded to the upper and lower faces of the longitudinal ones and connected at intervals by pairs of vertical strips. The flanges of each upper channel are cut away locally to clear the longitudinal members, so that the only upward projection is the web, and the joints at these points are reinforced by horizontal gusset plates. Since the webs of the lower channels are welded directly to the undersides of the longitudinal members, no notching or reinforcement is necessary. This interesting construction, which is clearly seen in one of the accompanying illustrations, is claimed to result in a weight saving of 25 per cent, on the complete vehicle, relative to more orthodox layouts. The suspension is by semi-elliptic leaf springs, of which those at the rear have a negative camber. Current practice is followed with regard to the other chassis details.

Another unusual Brossel bus chassis is the 103DAR, which was first seen at the Brussels Show last year. The frame construction closely resembles that of the 90DAR just described, except that the longitudinal members—which are of a special high-grade steel—have a rolled section with sharp external corners. On both these chassis there is a light cruciform bracing approximately midway between the ends of the longitudinals.

The Leyland O.680 engine is mounted horizontally behind the rear axle, and the transmission is of the semi-automatic type. An electric fan is employed to drive the ducted fan of the frontally mounted radiator, and it is controlled by a thermostat switch in the cooling system. This method of ensuring that the engine operating temperature is always kept within the optimum range is, of course, basically similar to that employed on the Lotus Elite car.

Combined air and semi-elliptic leaf springing is employed on both axles. At the rear, the leaf springs have a pronounced negative camber to enable the air springs to be installed beneath them, thereby obtaining the widest practicable spring base, for stability. There are two air springs on each side; they are of Pirelli manufacture and are of the type in which a helical spring is moulded into the rubber. Each pair of springs is mounted between angle brackets, bolted to the longitudinal members of the frame, and a saddle bracket attached to the axle tube. This suspension layout does not embody surge tanks.

The air springs of the front suspension, also made by Pirelli, are of the double-convolution type and are installed between the axle beam and angle brackets on the frame. Consequently, the leaf springs have an underslung mounting on the axle and are anchored to pendant brackets attached to the frame longitudinal members. The cylindrical surge tanks are mounted above the angle brackets, with an elbow connection to the air springs. Both these suspension systems are illustrated.

Heavy commercial vehicles with tandem front axles are less common on the Continent than in Britain. The reason for this is that our regulations regarding axle loadings are more stringent than those that have applied hitherto in most of the other countries concerned. However, as a result of the development of the European Common Market, an attempt is being made to achieve a satisfactory degree of international standardization on weight regulations. Broadly speaking, the proposed new regulations are more severe than before, so it seems likely that, when they come into effect, three-axle and even four-axle vehicles will become more common.

Among the few Continental manufacturers producing vehicles with tandem front axles are Fiat and Daimler-Benz A.G. The Fiat models concerned have the designation 690, with the suffix N, NS, T or TS. Of these four variants, the

first two—which are trucks—are identical except in that the engine of the model NS is turbocharged, whereas that of the N is normally aspirated. The 690T is the tractor version of the 690N, and the 690TS bears a similar relationship to the 690NS. Apart from the obvious difference in wheelbase between the truck and tractor series, the chassis specification is generally similar in both cases. Both the truck models have a payload of 13·5 metric tons, and the tractors are designed to carry a load of 11 tons on the fifth wheel.

The six-cylinder engine has a swept volume of 10·7 litres, derived from a bore of 125 mm and a stroke of 145 mm. Its features include a direct injection system giving high turbulence, and triple filtration of the oil: one of the filters is of the disc type and is automatically cleaned when the clutch pedal is operated. An external oil cooler forms part of the installation. The normally aspirated unit produces 150 b.h.p. at 1,900 r.p.m. and the output of the turbocharged version is 180 b.h.p. at the same speed.

A single-dry-plate clutch transmits the torque to a remote eight-speed gearbox, which is actually of the four-speed type with an auxiliary input reduction. The double-reduction rear axle provides an overall ratio of 6·887:1 on the model 690N, and 6·432:1 on the others. Tyres of 12·00—20 in section are fitted and there are twin wheels on the rear axle. A feature of the pneumatic braking system is that the front, rear and trailer circuits are independent. The handbrake is of the transmission type, and the engine incorporates an exhaust brake.

At all three axles, semi-elliptic leaf springs form the suspension medium. Double-acting telescopic dampers are installed at the front. A worm and sector steering unit is employed, and the system embodies power assistance in the form of an external hydraulic jack acting on a relatively complex linkage. The jack is installed almost horizontally, with the piston rod to the rear; the end of this rod is pivoted on the chassis frame, and the leading end of the body is similarly coupled to a slave lever of the rocking beam type, with a transverse pivot axis.

The jack is connected to the lever at a point below its fulcrum. An extension of the jack body projects forward of the slave lever, and is attached to the end of the drop arm, so the jack forms the link between the arm and the lever. To the lower end of the lever is attached the drag link for the leading axle, and from the upper end a rod extends rearward to the upper end of a second slave lever. The drag link of the trailing axle is connected to the lower end of this lever.

A Mercedes-Benz tandem-axle lorry chassis, the LP333 forward-control model, has already been in production for some time; it has recently been joined by an interesting tractor variant, with a shorter wheelbase, having the designation LPS333. Whereas the long-wheelbase model, of which the payload and all-up weight are respectively 14½ and 22 tons, has an orthodox layout of the steering axles, the LPS333 version is highly unusual in that the trailing axle is situated nearer to the rear axle than to the leading axle. The purpose of this feature is to enable the trailing axle to take the fullest possible share of the load.

On the LP333 chassis, the shackles for the springs of the leading axle and the eyes of the trailing axle springs are attached to common brackets on the frame. To obtain the more rearward location of the trailing axle on the LPS333, however, the shackle brackets of the trailing axle springs are combined with the eye brackets of the rear axle springs. This basic difference between the layouts of the two vehicles clearly necessitates changes in the steering linkage, to cater not only for the greater distance between the axles but also for the reduced steering angles of the wheels on the trailing axle.

The necessary modification has been ingeniously effected, without rendering any of the existing components redundant, by the addition of a longitudinal rod and a second slave lever, with its pivot bracket. In the standard arrangement, the drop arm carries the drag link for the leading axle and an intermediate rod extending rearward to a slave lever, to which the second drag link is also connected. On the LPS333, this slave lever is linked by the additional rod to the second slave lever, which is situated further to the rear and in turn is coupled by the drag link to the steering arm of the trailing axle, By the use of the appropriate lever

Above: The chassis of the standard Fiat 645N, 5 ton truck embodies pressed steel cross members, reinforced by short gusset pressings. Oblique channel sections brace the main cross member behind the gearbox

Left: A low-platform version of the Fiat 645N is available; its chassis frame is more complex than is the standard one. The example shown here is equipped to carry a load of crates, trays and gas cylinders

Right: The Fiat 1·8 metric ton 615N1 van has pleasing lines. A noteworthy feature of this Italian model is that independent front suspension is incorporated; it is carried on a fabricated transverse member

Below: A four-cylinder diesel engine of 1,901 cm³ swept volume is installed in the Fiat 615N1 van and truck. Its power output is stated to be 50 b.h.p. at 3,800 r.p.m.

lengths, the correct steering angles, relative to those of the leading axle, are obtained.

On both variants of this chassis, a ZF-Gemmer power-assisted steering system is installed. This system, which was described in detail in the December 1952 issue of *Automobile Engineer*, is of American design and was first fitted to certain Chrysler Corporation models. In essence, it consists of a worm and sector steering gear; rotation of the sector shaft in either direction is assisted by a hydraulic pressure differential between two opposed single-acting cylinders, the pistons of which are connected to a short lever on the shaft.

An unusual method is used of ensuring that the degree of assistance is proportional to the effort exerted by the driver. The worm shaft and steering column are not coaxial but have parallel axes and are coupled together by straight-tooth spur gears. When the steering wheel is turned, the resistance of the front wheels to movement gives rise to a reaction at these gears. This reaction causes the gear on the column to tend to run round that of the worm shaft. The column consequently moves bodily in one direction or the other, thereby operating the control valves. Since the tendency of the shaft to move increases with the reaction, so does the degree of valve actuation and hence of power assistance. To permit the necessary movement, the column is divided and the lower part mounted in a spherical bearing; a flexible coupling connects the two parts of the column.

The engine installed in both models is the familiar OM326.1 six-cylinder unit of 10·8 litres swept volume, the bore and stroke being 128 and 140 mm respectively. It embodies the Daimler-Benz precombustion chamber layout and has a compression ratio of 20·5:1. The power output, on the SAE rating, is 220 b.h.p. at 2,200 r.p.m. A single-dry-plate clutch transmits the drive to a six-speed gearbox with ZF synchromesh engagement for all ratios; the gear change is assisted by a pneumatic servo device.

Another feature worthy of mention is the layout of the axle, which embodies a double-reduction final-drive unit. Its secondary reduction is effected by spur gears in the hubs and, for this reason, the axis of the drive shafts is displaced to the rear of that of the wheels. The unconventional feature is that an axle beam of banjo form embraces the nose of the final-drive unit and is bolted to it; this beam carries the hubs and forms a seating for the springs. Since the final-drive unit is thus relieved of all the static and much of the dynamic loading, it is of relatively light construction, and the half-shafts are enclosed within thin-gauge steel tubes.

Before leaving these Mercedes-Benz models, reference should be made to the excellence of the cab interior. The engine cowling is effectively insulated against the passage of heat, fumes and noise, and is nicely trimmed in plastics-coated fabric, which is used also for the seat cushions and squabs. Adjustment is provided for cushion height and the rake of the squab. The door trim panels are of pegboard, as are the single-curvature panels lining the sides, back and roof; this material not only has a pleasing appearance but also serves to reduce noise, by virtue of the absorption of sound waves. For the double-curvature portions of the

On the Fiat 645N low-platform chassis, the members to which the rear springs are attached have a wider transverse spacing than have the main longitudinal members, which extend ahead of and behind them

Left: Good protection from the sun is given by the extended roof of this Labourier cab, the screen of which is flat. Another design feature of interest is the kerb-view windows

Below right: Rubbing strips are bolted to the sides of the Opel F300 van, which has a spot-welded bodyshell. The capacity is 9 m³

trim, moulded panels, covered in plastics sheeting, are used. Beech cappings surround the door lights, which incorporate a winder actuated fully opening window, a hinged ventilation panel and an additional draught deflector mounted on the guide rail at the leading edge of the drop glass. A slam handle is fitted to the inside of each door.

Among the wide range of commercial vehicles manufactured by Magirus-Deutz is the Saturn 195FS model, a heavy-duty tractor with a tandem driving axle arrangement. The two final-drive units are of the overslung worm type, and the axles are located longitudinally only by links, not by the springs. At each side there is an inverted semi-elliptic leaf spring, the ends of which bear on the top of the axle casings. The middle of each spring is clamped to a block, which pivots on a spindle mounted in a fabricated box bracket welded to the underside of the longitudinal member of the frame.

Each axle is located by three links, which lead in the case of the leading axle and trail in the other instance. Two of the links of each set are situated, one at each side, between the underside of the axle casing and the spring pivot bracket; the third, which is almost on the longitudinal axis of the vehicle, connects the top of the final-drive casing with a frame cross member positioned midway between the axles. The pivot bearings of the links are sealed by rubber gaiters.

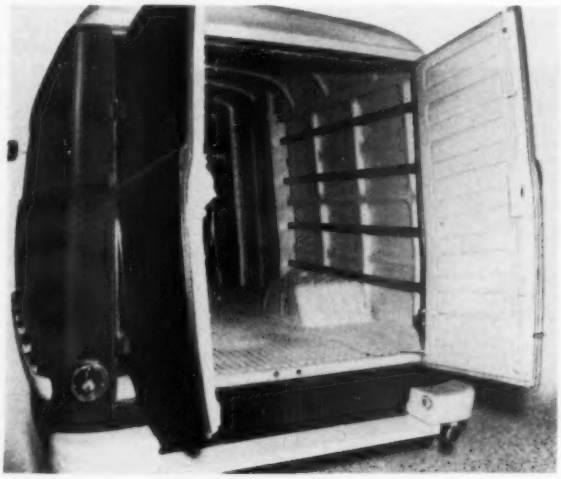
Medium weight vehicles

Three Fiat models fall in this category—the forward-control 645N, which has a payload of 5 tons, the 6·5 ton 650E developed from it, and the 1·8 ton 615N1 with normal control. The 645N chassis is available in truck form with alternative wheelbases of 2·93 m or 3·59 m—approximately 9 ft 7 in or 11 ft 9 in. In the case of the 650E, a version having a 4 m wheelbase, 13 ft 1½ in, can be supplied in addition to the two just mentioned. For the transport of crates, gas cylinders or similar goods, a low-platform version of the 645N model is produced; this vehicle, an example of which is illustrated, has a wheelbase of 3·7 m, about 12 ft 1½ in.

The engine of the 645N is a direct injection, six-cylinder diesel unit, which has a bore of 95 mm and a stroke of 110 mm, giving a swept volume of 4·68 litres. It is stated to produce 100 b.h.p. at 3,000 r.p.m. A more highly developed version of this engine is fitted to the 650E: it has an output of 110 b.h.p. at 3,200 r.p.m. The single-dry-plate clutch provides a degree of axial as well as torsional flexibility. Synchromesh engagement is provided for the upper four ratios of the five-speed gearbox. The rear axle ratios of the 645N and the 650E are respectively 5·857:1 and 6·833:1.

Although there is little that is outstanding in the chassis specification of these models, a few points call for comment. The cross members of the chassis frame of the truck versions are steel pressings riveted to the undersides of the top flanges of the longitudinal members. Most of them are of a top hat section, which tapers in depth towards the ends. Short swan-neck pressings, of inverted top hat section, form gussets between the ends of the cross members and the lower flanges of the longitudinal ones. Immediately behind the gearbox there is a box section cross member; resistance of the frame to lozenging is provided by four members, of channel section with pierced webs, that form braces across the corners between this cross member and the longitudinal ones and, with it, comprise an assembly of double trident form as viewed in plan.

The low-platform variant of the 645N has a more complex, partly welded frame with divided side members. Between the rear of the cab and the rear suspension, and again behind the rear wheels, the longitudinal members are relatively close together, whereas the section where the rear springs are

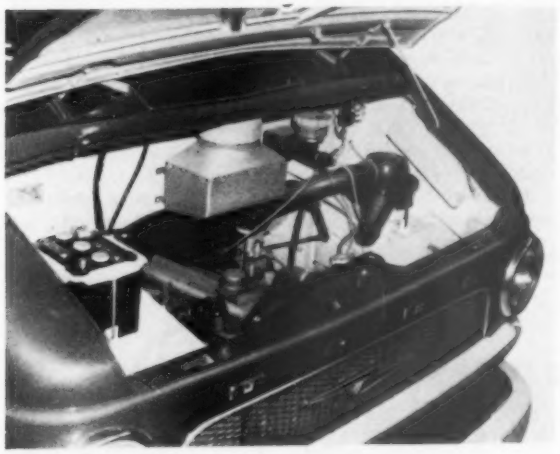


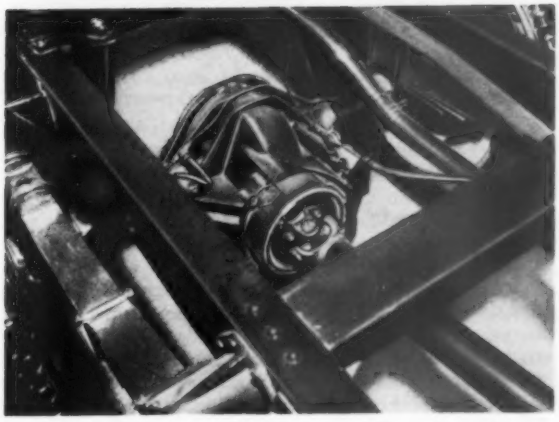
installed is of normal width, as is that on which the cab is mounted. Adequate rigidity is obtained by the use of deep-section cross members at the cranked sections of the frame, and by the outrigged low-level platforms at each side, which form an integral part of the structure.

On all models, both axles carry semi-elliptic leaf springs, controlled by telescopic dampers. The rear springs incorporate the usual helper leaves. Twin wheels are fitted to the rear axle, and on the 645N there is the option of 7·50—20 in or 8·25—20 in tyres; the larger section is standard on the 650E. The circuits for the front and rear brakes are independent and the exhaust brake is operated automatically by the pedal. In the layout and furnishing of the cab, considerable attention has clearly been paid to ensuring a high degree of comfort and convenience.

Van and open truck versions of the Fiat 615N1 are manufactured, the chassis being common to both. These models are developments of the earlier 615N series, from which they are distinguishable mainly in respect of a longer wheelbase, now of 9 ft 10 in, a more powerful engine, and an increase of 0·3 tons in the payload. The layout is outstanding by virtue of the use of independent front suspension in conjunction with an orthodox chassis frame. This suspension is of the double transverse wishbone type, and in design it closely resembles that fitted to the 1100T vehicles described and illustrated in the March 1960 issue of *Automobile Engineer*. It is mounted on a sturdy, fabricated transverse member bolted to the front of the chassis frame, to which it imparts the necessary high degree of torsional stiffness.

The engine is a four-cylinder diesel unit of 1,901 cm³, 82×90 mm, incorporating a swirl chamber combustion system. According to the makers, it has a power output of 50 b.h.p. at 3,800 r.p.m, or 26·3 b.h.p/litre. It is of interest to compare these figures with those quoted for the roughly comparable Perkins Four 99 engine of 1·62 litres. This British unit has an output, in commercial vehicle form, of 42 b.h.p. at 3,600 r.p.m, or 25·9 b.h.p/litre. For use in private cars, however, it is uprated to 43 b.h.p. at 4,000 r.p.m, equivalent to 26·5 b.h.p/litre.





Rather surprisingly, the wide doors of the two bodies are hinged at their trailing edges. Ahead of the hinge axes of the doors, both front ends are identical except in respect of the swaging on the door panels; this difference is due to the fact that, on the van, the line of the front wing crown is carried through, with a gentle fall, to the vestigial rear wing, whereas it fades out on the door panel of the open truck. The van body is of orthodox welded construction and has an unusually pleasant appearance, attributable partly to the well rounded rear quarters. Its sides are lined with hardboard and the inside of the roof has a coating of sound deadening material.

Another Italian vehicle of medium size is the Lupetto, the smallest of the extensive range produced by OM. It has a payload of 2·6 metric tons and an all-up weight of 4½ tons. A forward control layout has been adopted and the wheelbase, of both the van and open truck versions, is just over 8 ft 6 in.

The chassis frame is of straightforward construction, and embodies both riveted and welded joints. Behind the gearbox it is braced by a cruciform member, to the rear of which are three other cross members. Two of these are of channel section, and they are situated respectively at the front and rear anchorages of the long, semi-elliptic rear springs; above the rear axle is the third cross member, a pressing of top hat section, to which the upper ends of the telescopic dampers are attached. The front suspension springs also are long semi-elliptic components, used in conjunction with telescopic dampers. Independent circuits for the front and rear braking systems are specified and—an unusual detail these days—the transmission hand brake is of the external-contracting band type. The rear axle carries twin wheels and the tyre size is 6·50—16 in.

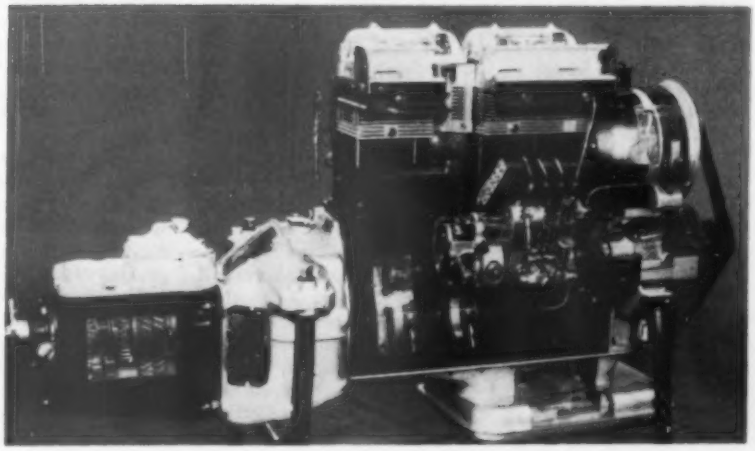
This vehicle is the only one in the OM range to have an air cooled engine. It is a four-cylinder diesel unit of 4,156 cm³ swept volume; the bore and stroke are 105 mm and 120 mm respectively. The crankcase is an iron casting, the skirt of which, for rigidity, extends well below the level of the crankshaft axis; the large-capacity sump is fabricated from steel pressings.

Cast iron is the material of the separate, closely finned cylinder barrels, which are spigoted into the crankcase. They are secured by the long holding-down studs of the two cylinder heads. The light alloy heads, also deeply finned, have inserts for the valve seats, A vertical disposition

Top: The 2·6 litre petrol engine of the Opel F300 and F330 vehicles is similar to that fitted to the Kapitän car. Since the fresh-air intake for the cab heater unit is immediately above the engine, the oil bath air filter is remotely installed

Above: Although the chassis layout of the OM Lupetto follows orthodox practice in major respects, a transmission handbrake of external-contracting type is employed

Right: The 4,156 cm³ diesel engine of the OM Lupetto 2·6 ton chassis is air cooled. Separate, iron cylinder barrels, and paired heads of light alloy are employed. Ducting is fitted round the heads and barrels, and the fan is incorporated in the generator



is employed for the valves, which are actuated by conventional push rods and rockers, from a side mounted camshaft. In the usual manner, the toroidal combustion chambers of the direct injection system are formed in the crowns of the light alloy pistons.

A ducted fan, combined with the generator and belt driven from the crankshaft, provides the cooling air, which is distributed by a cowl and a system of baffles reminiscent of aircraft engine practice. The element for the induction air filter is enclosed within the cowl. This interesting engine has an SAE output of 63 b.h.p. at 2,200 r.p.m, the net output being 56 b.h.p. The maximum torque, which is developed at 1,200 r.p.m, is 162 lb-ft. A 10 in diameter single-dry-plate clutch transmits the drive to a five-speed gearbox; there is a choice of ratios in the spiral-bevel final-drive unit, to ensure optimum performance in various operating conditions.

In the Opel F300 and F330 series, which has not long been in production, there is a choice of two wheelbases, 3 m or 3·3 m, the measurement being indicated in the suffix number of the designation. The maximum all-up weight of these semi-forward-control vehicles is 4¾ tons and, in each size, they are available as a chassis with front end and cab floor, as a chassis complete with cab, or as a van. A capacity of 9 m³ is quoted for the shorter wheelbase van, and 12 m³ for the other.

The six-cylinder petrol engine has bore and stroke dimensions of 85×76·5 mm, giving a swept volume of 2,605 cm³. It is virtually that fitted to the company's Kapitän car, except that it has a compression ratio of 7·0:1, instead of 7·8:1, and a carburettor with a smaller choke. As a result, the power output is reduced fron 89 to 79 b.h.p. at 4,200 r.p.m; the maximum torque remains unchanged at 137 lb-ft but the speed range over which it is developed is reduced substantially. For the car, the range is quoted as 1,300 to 2,500 r.p.m, whereas the commercial vehicle equivalent is 1,000 to 1,700 r.p.m.

Below: The German-made Ford Taunus FK1250 range is comparable with several produced in Britain. This chassis and cab variant is produced by building up the underframe structure to a convenient height

Although the chassis and the bodies are robust and well engineered, there is little about them that is indicative of advanced thought. The design of the frame and the leaf spring suspension systems follows current practice. Sliding cab doors are provided in the van body, the floor panels of which are liberally fluted, to add to their stiffness. This body is of all-welded construction, and the majority of its frame members have a top hat section. Ahead of the B pillars, the cab available on the chassis is almost identical with the front portion of the van body, except that hinged doors are employed instead of the sliding type.

Light vehicles

There appears to be little that is entirely new in this field since our last review, in March 1960. As might be expected, there have been extensions to the range of body types available on some of the more recently introduced models; an example of this is the police van version of the Renault Estafette described last year. To increase the scope of the Ford Taunus FK1250 series, which has a maximum payload of just over 1 ton, a chassis and cab version is now offered, in addition to the van, pick-up, small bus and other standard bodies.

In this version, the box section underframe structure is built up, by longitudinal and lateral members and valances, to a level above the wheel arches, thus facilitating the fitting of special bodywork. Swaging is extensively employed on the various vertical webs to increase their rigidity and to resist any tendency to resonance. An illustration on this page shows the manner in which the building-up is effected.

A neat little pick-up, with a payload of nearly 6 cwt, has recently been developed from the D.A.F. small car, using common body pressings

One of the smallest Continental commercial vehicles is the recently introduced D.A.F. pick-up, which is based on this company's small car, now being produced in considerable numbers. No changes have been made in respect of the 590 cm³ flat-twin engine, the Variomatic infinitely variable transmission, or the suspension systems. However, the underframe structure has been reinforced to withstand more arduous conditions of usage.

Below the waistline, the body pressings are common to both the car and the pick-up, but the sides of the latter vehicle, to the rear of the B pillar, have an inner skin embodying longitudinal stiffeners that serve as rubbing strips. Ahead of the B pillar, the superstructure is identical on both models, the cab of the pick-up being completed by a rear bulkhead in which is a large window. There is little encroachment by the rear wheel arches into the flat floor area. The tail gate opens to the horizontal, where it is held by two sheathed chains, and is retained in the closed position by a spring-loaded bolt at each side. A detachable, fabric top is available as an optional extra. This neat little vehicle has a payload of just under 6 cwt.

Finally, mention should be made of the fact that Perkins diesel engines are now optional on certain Citroën vehicles. The Four 99 1·62 litre unit mentioned earlier can be installed in the HZ and HY models, which were described in the March 1960 issue of *Automobile Engineer*. In addition, the standard 5 ton chassis can be fitted with the 3·14 litre P4 engine, which has an output of 49 b.h.p. at 2,400 r.p.m.

Left: View of the compressor installation on the Vauxhall Velox car. The condenser is mounted behind the radiator grille. Right: On the Humber Super Snipe, the experimental water evaporation unit was installed ahead of the front seat; the outlets of the vapour-compression unit are above the facia

MOTORING COMFORT IN HOT CLIMATES

Review of an Ambitious Test Programme Carried Out by Smiths Motor Accessories Ltd. on Air Conditioning Equipment

BECAUSE really high ambient temperatures are rarely encountered in Britain, there has been an understandable tendency in the past for our vehicle manufacturers to regard a fresh-air heater unit as sufficient protection for the motorist against climatic vagaries. However, in view of the large number of British cars, vans and trucks exported to countries having hot climates, greater interest is warranted in full air conditioning, that is, positive cooling as well as heating of the air when necessary. In spite of the high cost of the refrigeration equipment available in the U.S.A, it has been established that about 10 per cent of the cars in use there are so fitted. Since equipment of this type has not been available for more than a few years, and cannot usually be accommodated on earlier vehicles, it follows that the percentage of American cars currently leaving the production lines with full air conditioning must be substantially above the figure quoted.

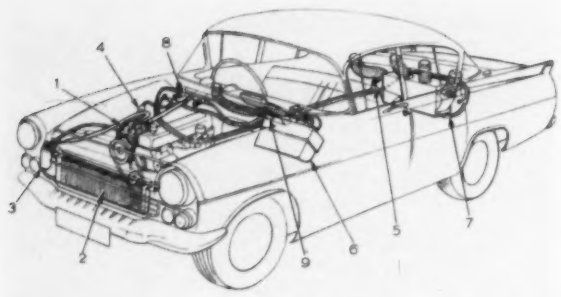
It is now about three years since Smiths Motor Accessories Ltd, at its Witney sub-division, began to investigate the possibilities and requirements of vehicle cooling systems, with a view to the eventual marketing of equipment of this type. After some initial work on orthodox cooling systems—those that lower the general temperature in the vehicles's interior—it was decided that a different approach seemed desirable. The reasons for this were that the additional weight and cost of a system of this type, about 110 lb and £150 respectively, rendered it unsuitable for the typical European small car. Attention was, therefore, turned to the local or spot cooling type of equipment, in which a small volume of cooled air is directed, at relatively high velocity, at the occupants' heads and chests. It appeared likely that, if the distribution of the air were correctly arranged, only a moderate cooling capacity would be needed, with a resulting substantial reduction in the cost and weight of the unit.

An intensive laboratory research programme was instigated to obtain initial data on the performance of systems for providing local cooling. Towards the middle of last year, the stage was reached when further progress could be made only by field tests in the appropriate climatic conditions. Consequently, the company sent two specially equipped cars —a Vauxhall Velox and a Humber Super Snipe—and a four-man team to the Tunisian desert last July.

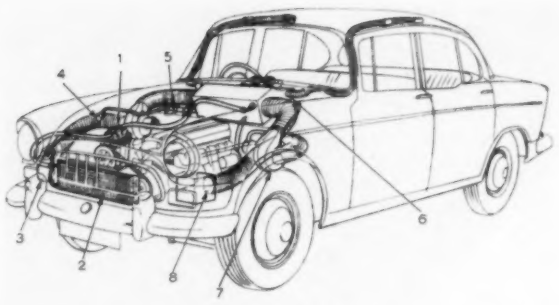
The main terms of reference of the expedition, which remained there for five weeks, were to obtain data on the following points: the effectiveness of fresh-air ventilation only at high ambient temperatures; the relative merits of general and local cooling; the effect of solar heat on the cooling load for the interior of the car; the optimum differential between the ambient temperature and that of the car interior; the speed with which the temperature could be reduced to the desired level after the car had been standing in the sun; the best distributional system for the cool air; and, finally, to gather any other useful information for subsequent hot-chamber tests in the laboratory.

The Vauxhall Velox was equipped with a refrigeration unit of the vapour-compression type, with a maximum heat extraction rate of 8,000 B.Th.U/hr—about 30 times that of a typical domestic refrigerator. Freon 12 dichlorodifluoromethane refrigerant was used and the system, which was purely recirculatory, embodied two evaporators of different designs: one was mounted on the facia panel so as to deliver cooled air at the head level of the occupants of the front seat; the other was installed in the boot and its outlets were above the rear parcels shelf. The system was arranged so that either of the evaporators could be brought into use.

Two different patterns of condenser were taken with this car, for comparative tests. In each case, the mounting was in front of the radiator block, but behind the grille, so it was necessary to assess not only the efficiency of each type but also its effect on the engine coolant temperature. One problem posed by this equipment was that of obtaining an adequate rate of airflow over the condenser at low engine speeds without incurring excessive power consumption by the fan, and possible over-cooling, at high speeds. This



1 compressor; 2 condenser; 3 liquid receiver; 4 filter and drier; 5 rear expansion valve; 6 front evaporator; 7 rear evaporator; 8 interchange valve; 9 front expansion valve



1 compressor; 2 condenser; 3 liquid receiver; 4 filter and drier; 5 expansion valve; 6 evaporator; 7 blower fan; 8 fresh air inlet

Layout of the systems fitted to the Vauxhall Velox, left, and Humber Super Snipe cars for Smiths' Tunisian expedition. The Humber car was fitted with a water evaporation cooling unit as well as the vapour-compression refrigerator and fresh-air system that can be seen in the right-hand illustration

difficulty was solved by the use of a Smiths viscous type of fan coupling, based on the Eaton design described in the July 1959 issue of *Automobile Engineer*.

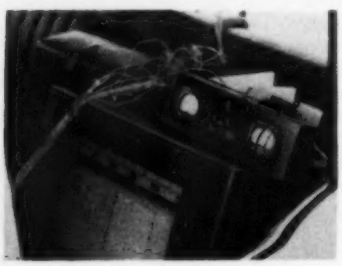
On the Super Snipe, ducting was arranged to direct fresh air at the driver and front seat passenger. It was thought desirable to embody this system because, so far as could be ascertained, no European manufacturer had scientifically assessed the effects in very hot climates of simple fresh-air ventilation, or even whether or not it was desirable to open any windows. The expedition, therefore, afforded a good opportunity of obtaining some basic information on this aspect of air conditioning.

In addition, the Humber vehicle was fitted with alternative refrigeration sets. One was a vapour-compression refrigerator unit of 5,000 B.Th.U/hr capacity, the outlets from which were above the facia and above the doors—either set of outlets could be brought into use at will. The second was of the water evaporation type, in which water is sprayed into a stream of fresh air. For experimental purposes only, this unit was installed on the floor, ahead of the front seats, and had integral outlet nozzles. The water evaporation method of cooling can, of course, work efficiently only in a dry atmosphere. Since the relative humidity of the air at a given temperature has a marked effect on comfort, the effect of the refrigerator on the humidity was among the phenomena to be investigated. The accompanying table indicates the reduction in air temperature that can be effected by this type of unit at various humidities; in each case, the air inlet temperature is 100 deg F.

Instrumentation

For the recording of all temperatures, copper-constanton thermocouples were used, but frequent cross checks of the ambient and interior temperatures were made with a standard mercury bulb thermometer. Each car was fitted with a total of 20 thermocouples. Of these, the readings of the majority were recorded by means of a Honeywell Brown automatic apparatus, the accuracy of which is ±0·25 deg F: they included the eight interior temperatures—four at foot level and four at head level—those of the refrigerant, at the entry to and outlet from both the evaporator and condenser, and the ambient and air outlet temperatures measured at the nozzles.

The remaining thermocouples served to record the body shell temperature, the ambient air temperature at the occupants' head level, and the engine coolant temperature entering and leaving the radiator. These readings were obtained with a Cambridge millivoltmeter, having an accuracy of ±0·4 deg F. Dean and Wood pressure gauges were used to record the suction and delivery pressure of the compressor on the Velox, and the relative humidity was measured by means of a Negretti and Zambra whirling type hygrometer.



The Honeywell Brown automatic recorder was installed on the rear seat. Temperatures not recorded on this were obtained with a millivoltmeter

Summary of conclusions

One of the most interesting facts revealed by the tests was the effectiveness of spot cooling, even when only a small proportion of the refrigeration capacity was employed. It was found that, where the ambient temperature was in the region of 100 to 115 deg F and the humidity was 40 to 45 per cent, an air supply of 20 ft³/min for each occupant, delivered at about 15 deg F below ambient, resulted in a reasonable degree of comfort. This delivery represents an individual cooling capacity of about 400 B.Th.U/hr, or less than 1,000 B.Th.U/hr for the front seat passengers only. Since this last figure amounts to only about $\frac{1}{12}$ of the capacity of an orthodox refrigeration system for a medium size car, it is clear that a system of the spot cooling type would be much cheaper to make. In addition, its much smaller bulk would facilitate installation in the engine compartment which, in most cars, is already fairly congested.

For spot cooling, the water evaporation unit in the Humber vehicle gave good results. It is considered by the Smiths team that a cooler of the type tested should have a satisfactory performance in any locality where a high ambient temperature is not accompanied by a relative humidity of more than about 40 per cent. A secondary advantage of this system is that the water spray has a significant cleaning effect on the air fed to the interior of the vehicle; in dusty climates a degree of filtration of the incoming air is regarded by Smiths as essential if large volumes are to be delivered at head level.

In the case of the full refrigeration system installed in the Velox, the tests revealed that, in ambient temperatures of 100 to 115 deg F and with the humidity at about 40 per cent, approximately 70 per cent of the cooling capacity was avail-

Table—EFFICIENCY OF A WATER EVAPORATION COOLER

Air relative humidity, per cent	*Air outlet temperature, deg F*	*Air temperature drop, deg F*
20	77	23
30	80	20
40	84	16
50	87	13
60	89	11
70	92	8
80	95	5
90	98	2
100	100	0

able as useful refrigeration. The balance was absorbed in the condensation of moisture. This proportion of the capacity produced an average interior temperature approximately 12 deg F below ambient when the car was travelling at 40 m.p.h. in the mid-day sun. To achieve this reduction, the temperature of the air leaving the evaporator was about 30 deg F below ambient.

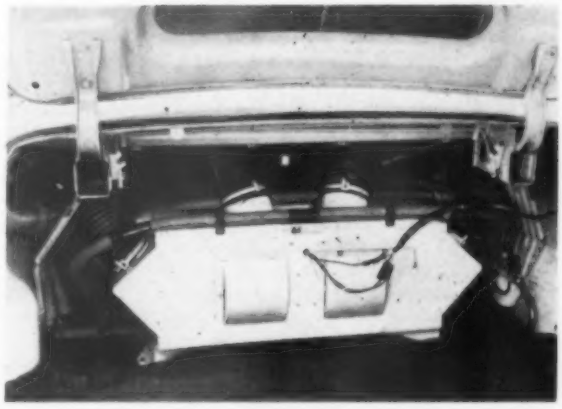
With the refrigeration system out of action, the interior temperature was found to rise, in the same conditions, by 18 deg F. It follows that the total reduction effected by the system was 30 deg. This figure confirmed the results obtained in the hot-chamber tests previously carried out in Britain.

The interior temperature obtained was unaffected by whether the air was distributed from the front or the rear ducts. However, the distribution from the front did increase the comfort of the passengers in the adjacent seat, because the air then flowed directly over their heads and chests. In the case of discharge from the rear, no marked discomfort was experienced as a consequence of the cool air striking the back of the head, provided that the flow was not too concentrated in that region.

During the tests without refrigeration, it was determined that, at speeds above 50 m.p.h, use of the fresh-air ventilation system was preferable to opening the windows, with the consequent buffeting and noise. Although, with the windows closed, the interior temperature rose to 10 deg F above ambient, a considerable feeling of comfort was derived from the delivery of 150 ft^3/min of fresh ambient air at the head and chest levels. This applied even with ambient temperatures as high as 105 deg F. However, these tests revealed that more air was drawn into the car through a forward mounted air intake than through one at the base of the screen, and the use of the second type of intake does not obviate the need of filtration.

Changes of the exterior colour of the roof were tried on the Humber car. No significant differences resulted from altering the original dark blue to light blue or light grey. However, when the roof was painted white, its temperature at 40 m.p.h. was reduced by about 15 deg F, and the interior temperature of the car was lowered by a worthwhile 3 deg F.

One of the alternative evaporator units fitted to the Vauxhall car was installed in the boot. The hoses seen here lead to outlet nozzles that are mounted in the parcels shelf immediately behind the rear seat squab



Identification of Stock

IN ANY factory, it is obviously desirable to have a clear and permanent means of identifying stock of all types. A simple and versatile identification system is provided by the GripsOn Stockmarker, a product of Kabi (Electrical and Plastics) Ltd, of Cranborne Road, Potters Bar, Middlesex. The Stockmarker equipment consists of small blocks, which are black polystyrene mouldings $\frac{3}{4}$ in high, and a roll of tape with adhesive on both sides and a backing strip on one side only. Some of the blocks have white, embossed letters or numbers, and the remainder are spacers and end pieces: assembly is effected by means of tenons and slots.

When the desired group of letters or numbers, or both, has been prepared, a length of the tape is applied to its back. The backing strip is then removed from the tape, and the group is pressed on to the stock container. Although the grip is permanent, the group can be levered off the container when necessary and can then be used again.

Insulating Tapes

ADHESIVE tapes are, of course, widely used today in the construction and installation of electrical equipment, and very exacting specifications are laid down by official bodies, such as the Atomic Energy Authority, and by manufacturers. To meet these requirements, the more progressive companies making these tapes have devoted much research to the development of new base films and adhesives. In this connection, Gordon and Gotch (Sellotape) Ltd. has issued a booklet dealing with the properties of its range of tapes for electrical installations.

As well as covering the physical and electrical characteristics of these tapes, the booklet deals with matters such as corrosion due to acid or alkali penetration, applications involving high-temperature, phasing and circuit identification; there is also some useful applicational information. The booklet, which has the title "Electrical Taping", is available from the Publicity Department of the Industrial Division of Gordon and Gotch (Sellotape) Ltd, 8 to 10 Paul Street, London, E.C.2.

Oil and Grease Remover

A COMPOUND for removing oil and grease from floors and other surfaces has been introduced by Oiltona Ltd, 464 Alexandra Avenue, Harrow, Middlesex. This compound, termed Oiltona, is similar to some of the dry compounds widely used in the United States. It is said to act as an absorbent and completely remove stains caused by oil from all types of floors, including porous concrete. It is neither inflammable, toxic nor abrasive. Another claim by the manufacturer is that it leaves no scum or stain, and can be used, therefore, for cleaning fabrics and carpets.

Fuel Additives CONTINUED FROM PAGE 60

Part II: The Surface Ignition Problem and its Solution by the Use of Chemical Agents

By E. M. GOODGER, M.Sc. (Eng.), Ph.D., A.M.I.Mech.E., A.F.R.Ae.S., F.Inst.Pet.

THE second major group of combustion problems that arise in spark-ignition engines falls under the general heading of surface ignition. As is well known, this is the phenomenon of secondary ignition by a heated surface within the combustion chamber. Such a condition can arise in the event of an overheated sparking plug, exhaust valve or, more usually, a glowing deposit of combustion products. The phenomenon manifests itself in different ways, depending upon the circumstances. In general, a portion of the charge is caused to burn before it would otherwise have been consumed by the spark-ignited flame, and in this sense the process may be termed *pre-ignition*.

In mild cases, surface ignition takes place well after the spark-ignited flame has been formed, and the condition may not be detected until the engine is found to continue firing, that is, to run on, after the electrical ignition is switched off. In more severe cases, the timing of the surface-ignited flame may, in fact, be prior to the incidence of the spark-ignited flame, so that the effects are similar to those of an over-advanced ignition timing, that is, roughness, noise, hot running, and eventually knock. Knock produced in this way is invariably erratic, and is termed *wild ping*.

Because operating severity is a contributory factor to both knock and surface ignition, and since high temperatures and pressures result in each case, the two phenomena are mutually provocative. In extreme cases, knock has been known to lead to physical damage to piston crowns, whereas failures as a result of surface ignition may occur in the form of melted pistons and battered valve springs.

Surface ignition is becoming particularly serious with the progressive trend to the higher consumption ratios and will probably replace knock as the limiting factor. Above a compression ratio level of about 9·5:1, the advanced-timing effect of surface ignition leads to a very high rate of pressure rise which, in turn, causes a shock vibration to occur throughout the power train. This condition is described as *rumble* or *pounding* and produces a very disturbing clatter, similar to that of a loose bearing or incipient mechanical failure.

Engine development has largely obviated the problems of overheated plugs and valves, but some solid combustion products appear to be unavoidable. Under severe conditions, accumulated deposits are liable to glow and act as unwanted sources of ignition. Remedies for deposit-induced surface ignition are the use of fuel additives, and these achieve their ends by one or more of the following mechanisms:

(*a*) reduction of the extent of the solid deposition
(*b*) increasing the glow temperature of the deposits
(c) reduction of the surface ignitability of the charge.

Examination of the published results for the materials shown in the following paragraphs reveals the mechanisms involved in each particular instance. The quantitative assessment of the effectiveness of these additives has, in the results quoted, been obtained from measurements of surface ignition frequency by two methods. In the first, surface ignitions are detected by means of an ionization-gap type of flame detector, in conjunction with a crank-angle sensing device. The second method involves the use of high speed cine photography and a quartz cylinder head. The latter method indicates also the number of individual ignition centres which, in some instances, is as high as six. An experimental method of fuel rating, on a surface ignition basis, also exists: iso-octane and cumene are used as upper and lower reference fuels respectively, and a heated test surface is incorporated in the combustion chamber.

Phosphorus

The controlling influence of phosphorus compounds upon surface ignition was discovered in 1946 and applied successfully in commercial motor gasolines in 1953. Of the three mechanisms outlined above, method *b* is considered to have the major effect. This conclusion is supported by the evidence of the glow temperatures, Table 2, obtained with deposit samples heated in laboratory ovens; but it must be borne in mind that ignition characteristics can change relative to each other when test conditions such as pressure, delay time, and oxygen concentration are changed. These results show that the normal glow temperature of carbon, which is in the region of 550 deg C, is reduced considerably by the deposits occurring when leaded fuels are used. Such deposits are more likely to glow, but the introduction of phosphorus raises the glow temperatures again, towards the original level. Too great a rise in glow temperature would be undesirable, since this would prevent the deposits from burning away, and give rise to a greater equilibrium mass.

This reasoning on the subject of glow temperature is supported by the curves in Fig. 10. During the tests, the engine was run for 150 hours with a conventional leaded fuel in order to build up equilibrium phosphorus-free deposits. The frequency of surface ignitions was determined by the ionization gap technique, the detection circuit being switched off during the passage of the normal spark-ignited flame, and wild ping was detected by means of a selective microphone. With a change over to a fuel containing 0·2T of phosphorus additive, the rate of surface ignitions, after a further 50 hours of operation, had dropped sharply and reached a new equilibrium at 28 per cent of the former level. A reduction also occurred in the proportion of surface ignitions leading to wild ping.

Since an appreciable running time was required to reach the new equilibrium condition, it is evident that phosphorus exerts its influence by altering the composition and behaviour of the deposits and not by a vapour phase reaction, which would have resulted in an immediate reduction to a new level.

Detailed investigation into the crank-angle timing of the surface ignition processes showed that the 0·2T phosphorus reduced the frequency of surface ignitions occurring later in the compression stroke, and eliminated entirely the earlier surface ignitions. Since the earlier surface ignitions are more prone to promote wild ping, this represents an additional benefit.

The phosphorus compounds investigated include a number of organic and inorganic phosphates, phosphites, and phosphonates, but most commercial success has been derived from tri-cresyl phosphate, TCP, which is $(CH_3C_6H_4)_3PO_4$.

Sparking plug fouling tests conducted with a four-cylinder aircraft engine also gave some evidence of mechanism *a*. Deposits resulting from the use of a phosphorus additive are generally soft and powdery and, therefore, slough off readily from the supporting surfaces. In the literature, there have been, however, some differences of opinion regarding this mechanism; there has also been some conflicting evidence on the resulting change in octane requirement. Fleming *et al*[10], for example, quote results showing an average increase of 25 per cent in the extent of deposition, and of 1·7 numbers in octane requirement, after an equilibrium condition had been reached. Jeffrey *et al*[11], on the other hand, from road tests with 19 cars, Fig. 11, show an average reduction in octane requirement of about 2 numbers. In the aircraft work discussed above, anti-knock tests were conducted under aviation conditions, F3 and F4 CFR, and in a single-cylinder aero unit; under those conditions the effect of phosphorus upon performance number of the fuel was found to be negligible.

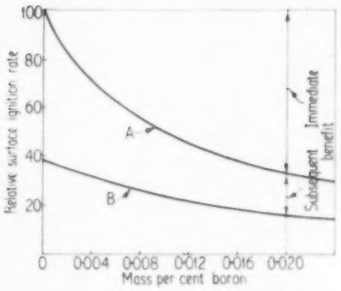


Fig. 13. The influence of additions of boron upon surface ignition

A *boron free deposit;*
B *0·004 per cent boron deposit*

As indicated in Part I of this article, phosphorus additives also have valuable subsidiary effects, which may even increase engine durability. In particular, the problem of sparking plug fouling is eased because of the increased electrical resistivity of the deposits, which contain phosphorus, Fig. 12. This prevents misfire, due to leakage of the electrical charge to earth, and consequent fouling of the cold plug.

Boron

Organic boron compounds exert a control over surface ignition, by a combination of methods *a*, *b*, and *c*. Improved scavenging of deposits is considered to be due to the formation of friable lead-boron compounds, which flake off from the chamber walls and escape with the exhaust gases. This is supported by reductions, up to 45 per cent, in the mass of deposits accumulating on piston crowns and exhaust valves[12]. With boron, as with phosphorus, glow temperatures of deposits from leaded fuels are raised towards that of carbon alone, Table 2.

Reduction in surface ignitability is demonstrated in the single-cylinder engine results shown in Fig. 13. The upper curve shows the relative rate of surface ignitions when the engine contained an equilibrium deposit of boron-free combustion products. Operation with different boron concentrations in the test fuel gave immediate reductions in surface ignition rates to the levels shown: this indicates a vapour-phase reaction reducing the surface ignitability of the charge. It is considered that this inhibition occurs during catalysis of CO to CO_2 in the pre-flame period. The lower curve was obtained when the equilibrium deposits were built up with a conditioning fuel containing 0·004 per cent boron. This further reduction in surface ignition rate is considered to be due to reduced deposition and increased glow temperature, as previously discussed. The change to boron-containing fuel offered an immediate improvement in respect of surface ignition, together with a further improvement with continued use. Highly aromatic fuels, which are more prone to surface ignition, are also more responsive to boron.

A useful subsidiary effect of selected boron additives is a small increase in anti-knock rating, Fig. 14. This effect is found only in leaded fuels, and is more marked with aviation mix Ethyl fluid than with motor mix. Again, reported effects in respect of octane requirement increase are conflicting, ranging from zero to a measurable reduction.

Organic compounds

Little detailed information has so far appeared on the effects of additives of a wholly organic nature, but there is some indication that certain organic esters provide protection from surface ignition by means of mechanism *a*, that is, by reducing the extent of deposition. These materials also

Table 2—APPROXIMATE GLOW TEMPERATURES OF COMBUSTION DEPOSITS, AVERAGE VALUES FROM SEVERAL SOURCES

Additives	Deposits		Deg C
Nil	Carbon	C	550
Lead and scavenger	Carbon + lead oxide	PbO	300
	Carbon + lead bromide	$PbBr_2$	200
	Carbon + lead oxybromide	$2PbO.PbBr_2$	230
Lead and scavenger plus phosphorus	Carbon + lead orthophosphate	$Pb_3(PO_4)_2$	460
	Carbon + lead bromophosphate	$3Pb_3(PO_4)_2PbBr_2$	350
Lead and scavenger plus boron	Carbon + lead borate	$PbO.B_2O_3$	340

Fig. 11, left: Change in octane requirement of an engine after 700 to 1,500 miles of operation with tri-cresyl phosphate additive dispersed in the fuel[11]
Fig. 12, right: The electrical resistance at high temperatures of deposits that contain phosphorus is better than that of those containing only lead

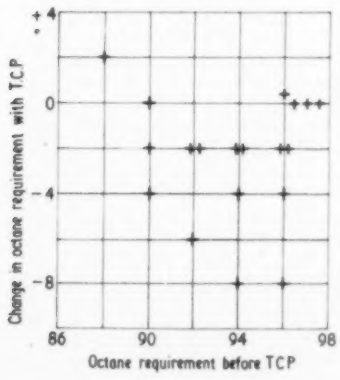
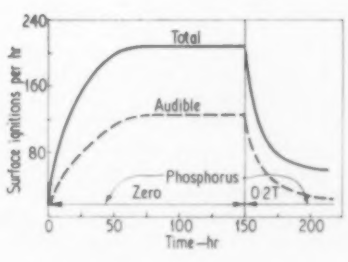
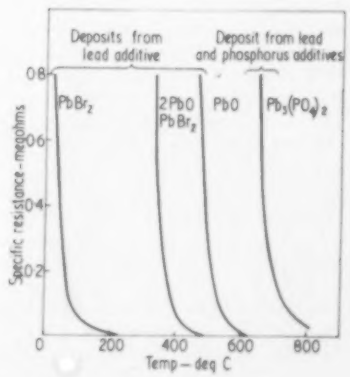
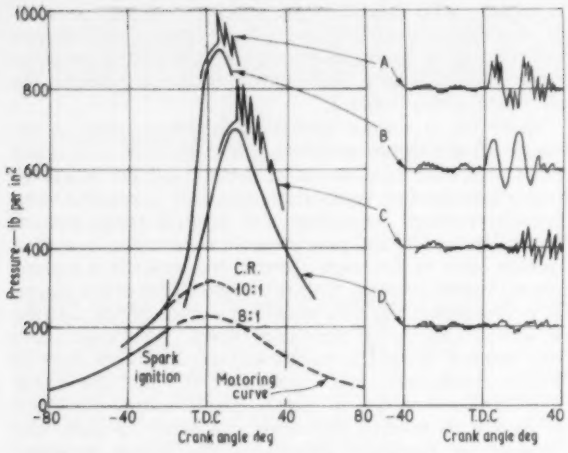


Fig. 10. Effect of phosphorus on surface ignition rate[8] *in an engine operated with a motor gasoline containing 3·6 ml TEL/Imp. gal and having a 93·1 road octane number*







A *rumble and wild ping—deposits;* **B** *rumble—deposits;* **C** *knock—clean;* **D** *normal combustion—clean*

Fig. 15. Indicator diagrams and noise records for combustion phenomena[14,15]

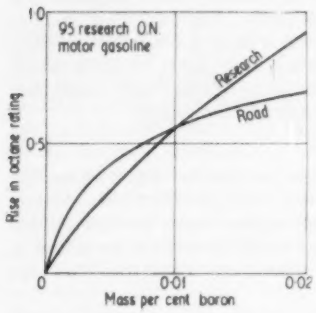


Fig. 14. Diagram showing the influence of boron on fuel octane rating

provide useful subsidiary effects in combating carburettor icing and acting as an upper cylinder lubricant. Carburettor icing is generally relieved by depressing the freezing point of the entrained water droplets, or by means of surface active agents that coat the metal surfaces of the induction system and prevent the build-up of ice. This same surface-active quality suppresses rust formation in the fuel system, and may be responsible for the reduced deposition in the combustion chamber.

The problem of ineffective ignition

In the compression-ignition type of internal-combustion engine, the major problem is one of excessive ignition delay after injection of the fuel, and this occurs when compression temperatures and pressures are too mild, for example, at cold-starting. When ignition does occur, the quantity of fuel present in the chamber is such that an uncontrolled explosive type of combustion takes place, instead of the desired smooth burning controlled by the rate of injection. This, of course, is *diesel knock*, and is manifested by rough running, heavy vibration and smoke. Additives can help in this problem, but their function is to promote combustion, not hinder it. Materials with a pro-oxidant action, which act as pro-knocks in the spark-ignition engine, are potential anti-knock additives for the compression-ignition engine. Although the knock problem is not so acute in the latter type of engine, a number of materials have been developed and are available commercially as diesel ignition accelerators. These include organic peroxides, nitrates, nitrites, and various sulphur compounds. The effectiveness of these agents does not approach that of TEL in gasoline, and the cost of the large quantities required for appreciable gain in *cetane number* — the anti-knock rating in compression-ignition engines—generally precludes their widespread use.

A further interesting application of pro-igniter additives is the wartime Ring process tested in Germany. The problem was that of failure of conventional electrical ignition systems in aircraft engines operating at high altitude. A proposed remedy was to effect ignition of the aviation gasoline by injecting, on a time basis, a small quantity of highly ignitable ether into the combustion chamber. Diethyl diglycol ethers were used, and effective ignition obtained, but this work was abandoned in view of improvements forthcoming in electrical ignition systems. An interesting subsidiary effect was the suppression of knock, and this was due to the elimination of an end gas zone resulting from multi-point ignition from widely dispersed ether droplets[13].

Conclusions

Combustion problems in spark-ignition engines may be subdivided broadly into uncontrolled spontaneous ignition at high pressure—knock—and uncontrolled surface ignition at comparatively low pressure — pre-ignition, running on, rumble, etc. These events are summarized in Table 3, and represented diagrammatically in Fig. 15, which also shows their resulting high and low frequency noise records. In the compression-ignition engine, the problem consists of an uncontrolled burning following an excessive delay at high pressure. It has been proved that additives can bring relief in all cases.

Although lead, in the form of TEL, has held supremacy as an anti-knock additive for nearly forty years, recent developments in engines and fuels have emphasized the need for alternative materials. Engine development is evident mainly as a progressively rising level of compression ratio, and this continuously accentuates the importance of the knock problem. Also, with automatic control of ignition timing, knock can be more prevalent at part-throttle operation, especially with the more sensitive fuels. It is interesting to note that TEL also exhibits an inhibiting effect on pre-ignition, as shown in Fig. 16. A similar saturation effect is noted with increasing lead concentration. It follows that leaded fuels provide a measure of protection against both knock and pre-ignition.

Developments in fuel refining have resulted in a wider use of catalytically reformed blending agents, and the peculiar distribution of anti-knock quality throughout the fractions demands lower boiling point lead carriers. TML may represent the solution of this problem. Manganese offers promise, particularly as a promoter to TEL, and attendant troubles with valves and plugs are mostly relieved by phosphorus. Some success is reported also with additives of a wholly organic nature. These are particularly attractive on the basis that their combustion products are of the normal hydrocarbon type and therefore less liable than the metallic types to leave ash deposits.

Water injection is a useful anti-knock measure, and it is cheap; the cost of the injection device could be recovered by virtue of the economies effected during about one year of average driving. Occasional attention to the adjustment of the injection system is advisable, and such a system is likely to have greater appeal to the enthusiast than to the more conventional motorist. As with lead addition, water injection also provides a useful measure of protection against pre-ignition. Naphthalene is not recommended as an anti-knock additive.

The ideal solution to the problem of surface ignition would be the development of both fuels and oils that burn without ash of any kind, since this would effectively eliminate unwanted sources of ignition. Although limited progress

has been made in this direction, combustion deposits are likely to continue to be experienced, for many years, in engines that are operated under most of the conditions liable to be met in normal service.

Phosphorus, in the form of TCP, exerts a marked inhibition effect upon surface ignition, by combining with the deposits and raising the glow temperature. Evidence on deposition rate and deleterious subsidiary effects is conflicting, but further work will probably indicate the reasons for these differences. The contradictory reports on effects on octane requirement may, in fact, be accounted for by the occurrence of wild ping during the test. In the absence of wild ping, the octane requirement represents a true measure of the fuel quality necessary for freedom from knock, and phosphorus may not be beneficial. If, however, octane requirement is determined by the onset of knock in the form of wild ping, the result represents a combined measure of both surface ignition and knock, and the undisputed benefit provided by phosphorus in the case of surface ignition may well by far outweigh any adverse effects on the normal anti-knock requirement. Boron exhibits a triple effect, in reducing the extent and activity of the deposits, and the ignitability of the charge. A number of organic additives are available for surface ignition control, but little information has appeared in the technical literature.

The development of a new additive is inevitably time-consuming and expensive, particularly when considered in relation to the likely sales volume, even if successful. Development time tends to increase, rather than decrease, owing to the ever widening range of engine operating conditions and the increasing number of additives coming into use: large numbers of tests are required both to cover the operating ranges, and to examine possible interaction between individual additives in relation to engine durability. Other motor gasoline problems that may be solved by means of additives include gum formation, storage instability, TEL destruction by sulphur, and incomplete combustion of the fuel in the engine cylinders.

With the progressive rise in compression ratio, the significance of surface ignition, and of its remedial additives, is likely to grow. Research can be expected to continue, with the aim of finding other remedies for the combustion ills incurred by the high performance of the modern motor engine. Further development of additives, to be used in small doses only, will ensure their rating high on the list of remedies that can be applied to cure ignition troubles.

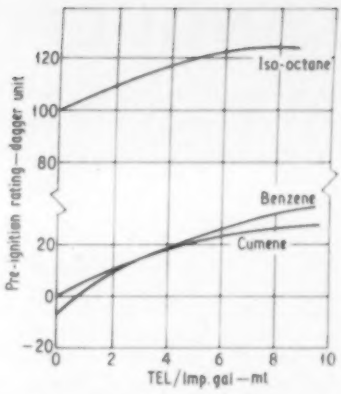


Fig. 16. Variation of pre-ignition rating with additions of tetra-ethyl lead to iso-octane, benzene and cumene

References

8. J. B. HINKAMP and J. A. WARREN: "Surface ignition control by phosphorus fuel additives", *Industrial and Engineering Chemistry*, Feb. 1958, p. 251
9. V. E. YUST and E. A. DROEGEMUELLER: "Spark plug fouling—its cause and control", *S.A.E. Journal*, May, 1952
10. C. L. FLEMING, N. V. HAKALA and L. E. MOODY: "Combustion chamber deposit control", *Petroleum Refiner*, Aug. 1954, p 88
11. R. E. JEFFREY, L. W. GRIFFITH, E. DUNNING and B. S. BALDWIN: "Improve fuel with phosphorus additives", *Pet. Ref.*, Aug. 1954, p.92
12. E. C. HUGHES and E. O. HOOK: "Results of the use of boron as a gasoline component", presented to *National Petroleum Association Meeting* at Cleveland, 20th April, 1956
13. R. J. BENDER: "Use of ether as ignition agent", *Automotive and Aviation Industries*, Sept. 1946, p. 40

Bibliography

14. E. M. GOODGER: "Abnormal combustion", *Automobile Engineer*, March 1960, p. 94
15. A. E. FELT, J. A. WARREN and C. A. HALL: "Rumble—a deposit effect at high compression ratios", *S.A.E. Trans.* N.Y, 1959
16. D. DOWNS and J. H. PIGNEGUY: "An experimental investigation into pre-ignition in the spark-ignition engine", *I. Mech. E. Auto. Div. Proc.* 1950-51, Part IV

Table 3—COMBUSTION PHENOMENA THAT ARE EXPERIENCED IN SOME MODERN PISTON TYPE ENGINES

	Spark-Ignition Engines			Compression-Ignition Engines
	Knock	*Surface Ignition*	*Rumble*	*Diesel Knock*
Mechanism	Spontaneous ignition of end gas at high pressure	Additional ignition of charge by hot surface at lower pressure	Additional ignition leads to high pressure rise rate	Delayed spontaneous ignition of excessive fuel charge at high pressure
Promoting conditions:				
Pressure—C.R.	High	High	High	Low
„ —Manifold	„	„	—	„
Temperature	„	„	—	„
Effects	Roughness High-frequency noise Physical damage to piston Wild ping	Roughness Low frequency noise Thermal damage to piston Physical damage to valve springs Running on	Roughness Low frequency noise	Roughness Low frequency noise Smoke
Rating method	Octane number, iso-octane + *n*-heptane	Experimental "Pre-ignition octane number", iso-octane + cumene	Aural	Cetane number, cetane + α methyl naphthalene
Controlling additives	Lead Manganese Organics Water Naphthalene	Phosphorous Boron Organics	Phosphorous Boron Organics	Peroxides Nitrates Nitrites Sulphur compounds Ethers

LANGUEPIN SPARK EROSION MACHINES

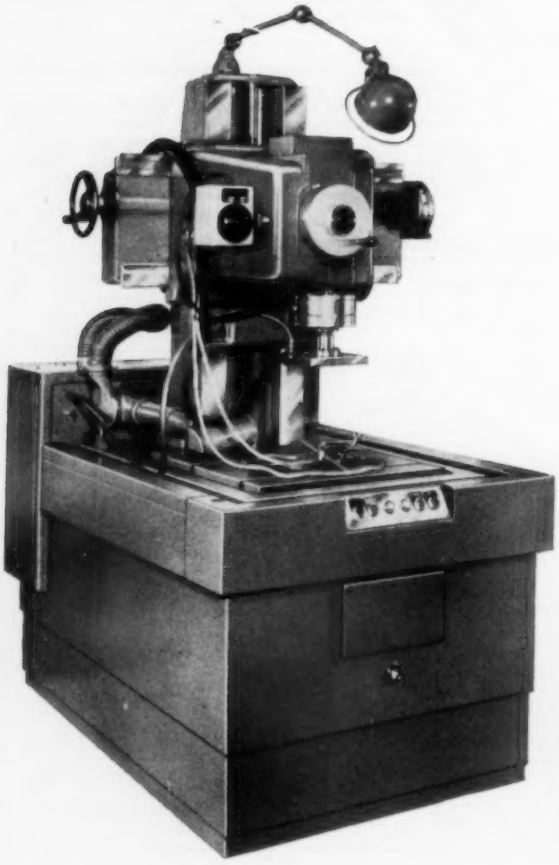
New Range Affords Choice of Precision or General Purpose Equipment

IN its relatively short industrial application so far, spark machining has proved to be, by a wide margin, the most economical method of forming irregular-shaped holes in extremely hard materials and of producing intricate die shapes with a minimum of difficulty. For example, in the repetition production of forging dies, the spark erosion process has been found to be a system capable of ensuring consistent accuracy, from die set to die set. With the extension of applications of this technique to many branches of industry, there has been the development of more advanced spark erosion machine tools that raise the standards of accuracy of working and eliminate some of the drawbacks that have been found to exist in respect of earlier machines.

A new range of spark erosion machines has been introduced by a French company, La Soudure Electrique Languepin, of Paris, and these machines are now available in the United Kingdom through the agency of a new Anglo-French company, Solar Weld Languepin Ltd, Fulledge Works, Burnley, Lancashire. There are three machines in the range and each incorporates a retractable tank for the dielectric fluid. The tank completely surrounds the worktable and rises to a working level so that during an operation, the worktable, workpiece and electrode are submerged. The need to fill and empty the tank for every erosion operation is obviated, and time is thereby saved.

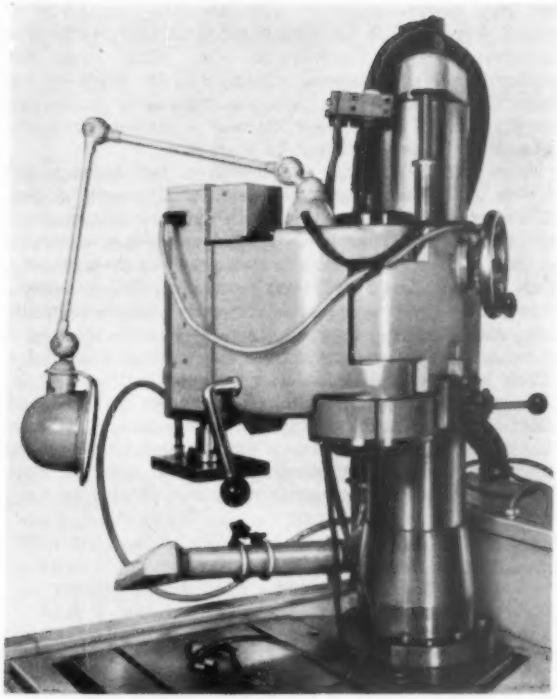
The two larger machines, designated "Seleromat" A and B, are pedestal-mounted machine tools; the smaller "Seleromic" machine is a bench-mounted version. A complete Languepin spark machining installation comprises the machine tool, a spark generator, which is housed in a separate cabinet, and a complete filtration unit. Identical spark generators, filtration units and electrode-carrying servo-heads are incorporated in the Seleromat A and B models, and in each of these machines the dielectric tank is raised and lowered by an electric motor. Maintenance of the level of dielectric in the tank is automatic, and a safety device is incorporated to switch off the current if the electrode ceases to be immersed.

The worktable of each of these large machines measures 20 in × 25 in, has two T-slots for work-clamping bolts, and will support workpieces weighing up to 1 ton. Incorporated in the base of the machine are the supports for the worktable,



Left: Seleromat B, ready to accept electrode and workpiece, with the tank for dielectric fluid retracted. The pipe leading to the electrode carrier is the fluid feed. Above the carrier is the vibrator unit

Below: When the tank is in the raised position, the level of fluid is maintained automatically. Minor adjustments, during setting of electrode height, are controlled by buttons at the front of the worktable



Seleromat A has the same worktable as Seleromat B, and the servo head can be swung clear to allow free access from above to the whole area of the table. Projecting from behind the pillar is a fume extractor

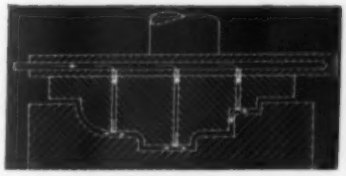
and the housing for the 100-gal dielectric tank and its pumping equipment. The flushing away of erosion debris is achieved by high-pressure feeding of the dielectric fluid through the electrode, by the explosive effect of the spark discharge and by vibration of the electrode.

In the Seleromat A, the electrode carrier and its servo-head comprise an integral unit at the outer end of an articulated arm that slides vertically and swings horizontally on a pillar. Major vertical movements of the arm are controlled by a worm-driven telescopic screw, and quick-action levers clamp the arm to the pillar. Fine horizontal adjustment of the arm, for electrode positioning, is made by means of a simple screw device positioned at the elbow joint.

The servo-head is carried in opposed V-slides and has a vertical travel of 4 in. Its motion is effected by a split-field d.c. motor, used in conjunction with a reduction gear, driving a leadscrew, and control is effected by a pair of push buttons on the front of the worktable. Automatic down-feed of the electrode is governed by electrical trips, and the depth required can be pre-set in increments of 0·001 in on a micrometer scale, although the scale calibration is wide enough for this increment to be halved in practice. The electrode carrier at the base of the servo-head is electrically insulated, and a vibrator can be interposed which, having a vertical movement of 0·0005 in at a frequency of 50 c/sec, provides the mechanical pulsation that assists in the flushing of debris from the discharge area.

The Seleromat B is a derivative of the A model. Its base and dielectric tank system are essentially similar, but the erosion head is mounted on precision co-ordinate slides that provide extremely accurate positioning of the electrode over the workpiece; the co-ordinate movement dimensions are 9 in by 12 in. A column at the rear of the machine carries the cross slide assembly on twin vertical slideways, and vertical movement is again controlled by a worm-driven

The dielectric fluid is circulated through holes in the electrode and its carrier plate



screw. Carried on the cross slide, and at right angles to it, is the longitudinal slide, on which is mounted the saddle for the erosion head. This saddle is traversed by means of a precision leadscrew fitted with a large-diameter micrometer drum with a vernier setting arrangement. Saddle locks are provided, together with precision longitudinal scales. The micrometer drums can be calibrated in 0·01 mm or 0·001 in graduations, as required, and illuminated optical vernier equipment is also available for attaining a high order of accuracy of setting.

Although primarily intended for laboratory work or for the manufacture of small items such as wire-drawing dies, the "Seleromic" is equipped with manually operated retrac-

In the Seleromic bench model, raising and lowering of the tank is done by the handle on the right

tion mechanism for its dielectric tank. There is no forced circulation of dielectric, for the erosion rates of the items treated on a machine of this size are extremely low. Several refinements are incorporated in this model that are not usually found in machines of similar size, but there is no precision control of the lateral movements of the work head. A more elaborate version of the "Seleromic" is planned, with accurate controls for electrode positioning. It will be designed and built in this country.

The generator unit for common use with Seleromat A and B spark erosion machines, designed to maintain powerful and regular spark discharges, is housed in a steel cabinet 83 in high, 55 in wide and 28 in deep. Power is derived from a three-phase a.c. supply of 440 volts at 50 cycles. The output voltage of a single-phase alternator is tuned to a predetermined value and fed into a bridge rectifier circuit. Positive pulses from the rectifier bridge are used to charge one of four banks of capacitors, which discharge between the electrode and the workpiece.

A "warm-up" delay switch is fitted to the full wave bridge rectifier. Housed in the cabinet is a push-pull servo amplifier for maintaining a constant spark gap between electrode and workpiece. The amplifier controls the motor in the erosion head of the machine, and the voltage across the spark gap

is integrated and compared with a reference voltage. Any error is amplified and fed directly to the servo motor to make the necessary corrections to the gap width.

A four-position heavy-duty switch controlled from the front of the cabinet is used to select the rate of erosion. The settings are marked "roughing", "semi-roughing", "finishing" and "super-finishing". A small pilot switch, working in conjunction with the heavy-duty switch, open circuits the d.c. excitation supply to the alternator field and, therefore, allows the range to be changed without touching any other controls. This ensures that the switch is always operated when the passage of current has ceased, and consequently very little wear occurs at the contacts.

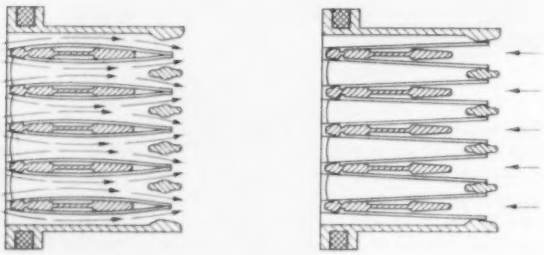
Provision is made for the movement of the servo-head to be stopped automatically at any predetermined depth of penetration without switching off the complete generator equipment. Alternatively, the controls can be set to switch off the whole installation at a predetermined depth. By this means, the equipment can be left running without attention for considerable lengths of time.

Filtration of the fluid at the rate of 11 gal/hr is afforded by a unit which is a separate entity from the generator and the spark erosion machine. The filter comprises 19 cylindrical elements, built up from paper discs, and will remove particles down to 1 micron in size. Fluid enters the elements from the exterior and deposits its solids on the edges of the packed discs. The accumulation of these solids on the surface of the filter element is removed by compressed air, blown through the element.

A pressure of 30 lb/in^2 is desirable for back-blowing, and this is usually obtained from the shop air supply system. Where shop air line supplies are liable to be contaminated, however, the use of standard cylinders of nitrogen delivering at 30 lb/in^2 is an economical way of ensuring clean blowing. One such cylinder will last approximately 6 months. Renewal of the filter packs is required at about 12-month intervals. The necessary frequency of element cleaning is dependent on the amount of heavy-rate erosion work undertaken, but on single shift working it need not exceed twice per working week. Deposits removed from the filter pack exterior are collected in a special tray built into the filter unit. The unit incorporates two pumps, one for scavenging from the erosion machine and the other for returning clean dielectric fluid to the container on the worktable.

Non-Return Air Valve

A DIRECT air flow valve has been introduced recently by Alan Muntz and Co. Ltd, of Browells Lane, Feltham, Middlesex. It is the subject of a patent and is the result of more than ten years' development work, followed by some three years' testing in service. During this time, the valves have been run in special air compressors operating at 3,000 r.p.m, and endurance tests of 5,000 hours at 2,500 r.p.m. have been carried out without failure. Tests on a suction valve at 5,000 r.p.m. have also been completed successfully. By fitting the valve to a commercial air compressor, the output was increased by 20 per cent and the fuel consumption decreased by about 10 per cent. Although the valves were originally designed for air compressors, recent experience has shown that they are also suitable for use in two-stroke engines and chemical plant requiring quick acting non-return valves.



As can be seen from the accompanying illustration, this valve differs from more conventional automatic ones in two important respects. First, the sealing blades trail in the direction of flow, with the result that the air does not have to change direction as it passes through the valve, and the losses are, therefore, low. Secondly, the blades do not move bodily to open the valve, but roll back from a fixed edge: this action, and the consequent low inertia loading, results in not only smooth and progressive opening and closing but also long life and the ability to operate at high speeds.

The design of the new valve was based originally on that specified in the patents of Schurter and Eichelberg; but as more experience was obtained, new features were evolved and incorporated in the latest units. In the range now being manufactured, there are two classes, of which the first is designed to give the lowest possible losses and is principally intended for operation on the suction side of a compressor, where temperatures are low. The second group of these valves was designed to withstand higher temperatures and more severe pressure reversals: as a result, their losses are slightly higher than those of the first group. To cover a wide range of applications, the valves are designed so that the number of sections in each can be varied to suit the throughput required.

All the valves are rectangular in shape and, therefore, pockets to contain them can be easily cored in castings. Generally, these pockets are satisfactory in the as-cast condition, but, if necessary, broaches can be passed through to give them a better finish. Apart from this, the only machining required is that for the flat sealing face on which the valve seats when it is installed in its housing.

Coach Heating

IN THE January 1961 issue of *Automobile Engineer* there was an article describing the Clayton Dewandre coach heating system, in which only one heat exchanger and fan assembly is employed. It has since come to our notice that a similar arrangement, termed the Dawson system, was used about two years ago on vehicles operated by Scottish Omnibuses Ltd, of New Street, Edinburgh.

Cromard Liners

DIESEL and petrol engine manufacturers with plants in Spain, South Africa, India and Jugoslavia may be interested to know that Laystall Engineering Co. Ltd, of Dixon Street, Wolverhampton, have completed agreements for the production of their Cromard, chromium plated cylinder liners in these countries. Moreover, liners of their range are already scheduled for initial fitting in locally produced diesel engines in all these countries except South Africa.

New Plant and Tools

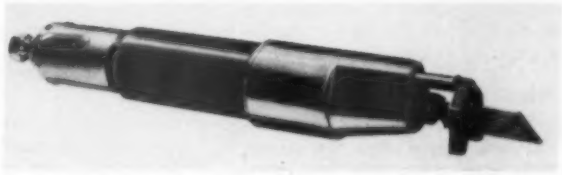
Recent Interesting Developments in Production Equipment

AN automatic lathe for the rapid production of small, slender components, is now being manufactured in this country under licence from the Bechet Co. of France. This machine is marketed by Dowding and Doll Ltd, 346 Kensington High Street, London, W.14, and built by Parker Engineering Service Ltd. It incorporates a sliding head, five toolholders and a drilling, tapping and screwing unit that embodies three spindles.

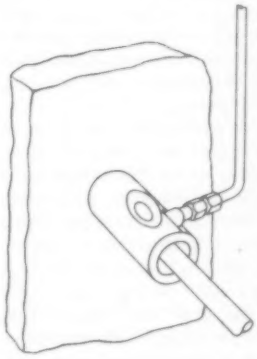
Two of the spindles are for operations such as drilling, reaming and centring, and they can be used when either stationary or rotating. The third spindle is for threading operations, and enclosed gears are incorporated for the purpose of varying the speeds according to the pitch of the screw; in addition, this spindle can be run in reverse. Of the five toolholders on the tool bracket, three are on slides disposed radially above the work area, and the other two are on a rocking beam below it; all five have micrometer adjustment in both radial and longitudinal directions.

Lathes with capacities for either 16 mm or 10 mm diameter bar can be supplied, and a slotting attachment is available for the 10 mm model. The spindle speeds of the two models are from 570 to 5,700 r.p.m. and from 900 to 9,000 r.p.m. respectively, and for each speed there is a choice of 50 camshaft speeds. Components up to 4 in long can be produced, and production rates of from 6 to 1,800 per hour are possible, according to size and complexity.

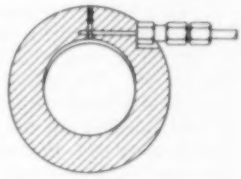
Single spindle, sliding head automatic lathe
(Dowding and Doll Ltd)



Weighing 5 lb, this pneumatic hand saw has a stroke of ¾ in. A file chuck, to replace the saw collet, can be fitted if required
(Consolidated Pneumatic Tool Co. Ltd)



A lubricant injector for adaptation to pressure die-casting machines
(Foundry and Metallurgical Equipment Ltd)



Pneumatic Saw and File

A new, lightweight hand tool that accommodates either a saw blade collet or a file chuck, has been introduced by the Consolidated Pneumatic Tool Co. Ltd, 232 Dawes Road, London, S.W.6. It is powered by an air motor, the rotary motion of which is converted by a cam system to reciprocatory motion. The speed of operation of the blade or file is 1,500 strokes/min and the stroke length is ¾ in. A manually operated valve is employed for starting and stopping the mechanism, and a built-in speed regulator can be used to adjust the cutting rate to the requirements of the task in hand. For the lubrication of the motor, oil is contained in a reservoir incorporated in the handle, and the gears are manually lubricated by removing a plug and pouring oil in through a filter. In order to keep swarf clear of the work, the air exhausted from the motor is directed downwards, through the nose of the tool, to impinge on the blade or file. The weight of the unit is 5 lb and the overall length is 14½ in.

Lubricant injector for pressure diecasting machines

Foundry and Metallurgical Equipment Co. Ltd, of Netherby, Queens Road, Weybridge, Surrey, have introduced an automatic lubricant injector for the plungers of pressure diecasting machines, where the use of heavy lubricants is generally considered essential. The injector assembly is a two-stage unit capable of dispensing heavy graphite-bearing compounds: the first stage draws lubricant from a supply tank and pumps it to the second stage at a pressure of approximately 200 lb/in^2; from there the lubricant is pumped at pressures up to 1,500 lb/in^2 and in quantities ranging from 0·045 in^3 to less than 0·005 in^3. For precision in delivery of lubricant, distance pieces of lengths that vary according to the quantity required are incorporated. The

pumping system has a full scavenging action which ensures that build-up within the system is prevented.

With the injector in operation on a pressure diecasting machine, an injection is made after every cast, and this affords consistent but not excessive lubrication. Economy of lubricant is one of the advantages of the system, and there is reduced wear on both plunger and sleeve. In addition to this, the lubricant injector can be fitted to existing machines. The unit operates from a compressed air supply of 60 to 150 lb/in^2, and it can be controlled by an air pilot, a solenoid or a mechanical roller system.

Press transfer feed unit

By the addition of the Turner self-contained transfer feed unit a standard press can be converted, without modification, into a transfer feed press. This transfer unit is operated either pneumatically or hydraulically, or its motion can, if desired, be mechanically linked to that of the press. As can be seen in the illustration, a row of fingers is mounted on each of two long parallel transfer bars. When the unit is in operation these bars are situated along each side of the lower dies of the press. Between pressing operations they are given alternately longitudinal and transverse movement so that workpieces are gripped, carried to the next station, and deposited.

At each end of the base plate of the transfer feed unit is a guide block in which slide two short rods, each of which is parallel to and rigidly attached by a short arm to a transfer bar. With the unit in the rest position, these arms are disposed vertically, with the bars above the rods. Thus the movement of the transfer bars is longitudinal when the rods slide in their guide blocks, and lateral when the rods and arms rotate through a small arc. At one end of the unit the two rods are extended and their ends threaded, so that they mate with two nuts that are fixed in a crosshead. One of the nuts has a left hand thread, the other a right hand thread, and the threads are of an identical coarse pitch.

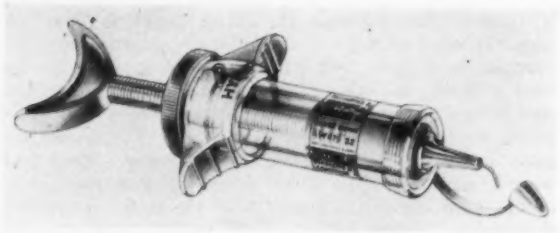
In the illustration the crosshead is in the foreground. Its intermittent reciprocating action is imparted by two pneumatic cylinders mounted parallel to the transfer bars. At this end of the unit there is a track block set between the two arms that join the transfer bars to their guide rods, and on each arm there is a lug that registers in a groove in the adjacent side of the track block. Since the configuration of the grooves is such as to constrain the arms initially to move only rotationally, and this motion is imparted by the action of the nuts in the crosshead, the movement of the crosshead at first does not give corresponding longitudinal motion of the transfer bars. Thus, the rows of fingers approach and grip the workpieces.

Further movement of the crosshead then causes the bars to be displaced longitudinally, and the work is progressed through the die. At the end of its stroke, the crosshead trips a switch and the cycle is reversed: the fingers release their grip and return to start the cycle again. Various interlocking devices are incorporated to ensure that the press does not operate when work is being transferred nor when there is a drop in the pressure of the air supply to the pneumatic cylinders.

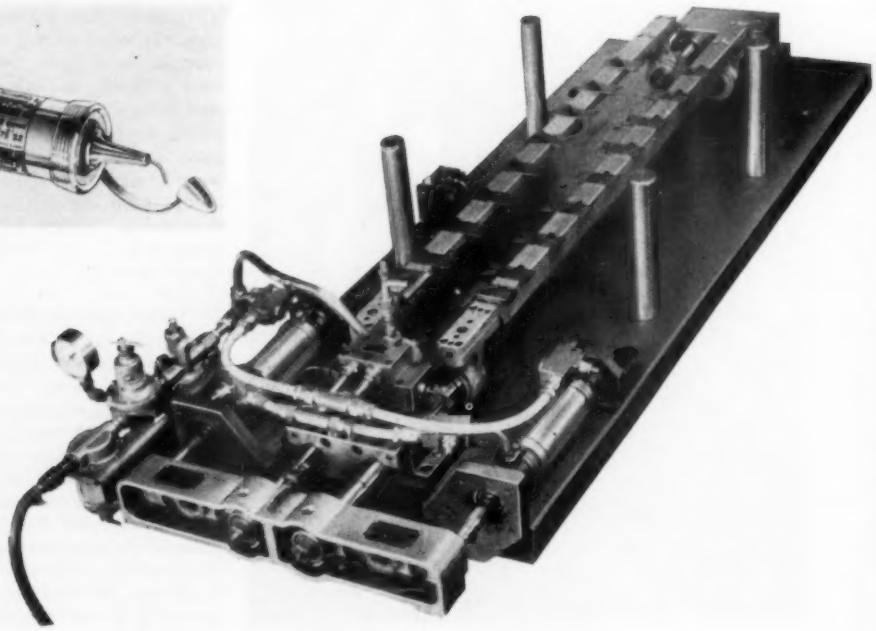
The standard transfer feed unit has a tool space of 28 in × 4 in, that is, 7 pitches of 4 in, or any similar combination. However, special units can be supplied according to requirements. The unit is readily removable from the press, to allow for reversion to normal working. Its manufacturers are Turner Brothers Ltd, Galvanic Works, Cliveland Street, Birmingham.

Syringe for diamond lapping compounds

Since cost is the most significant feature of diamond lapping compounds, as compared with other lapping materials, it follows that in the interests of economy all waste must be minimized. In any lapping operation, only a minute quantity of diamond paste is employed and great economies are possible if complete control is retained over the amount used each time. With this in mind, a new micrometer-action dispenser, known as the "Hyplicator", has been introduced by Engis Ltd, of Gabriel's Hill, Maidstone, Kent, who are manufacturers of "Hyprez" diamond grinding and lapping compounds. These compounds may cost as much as £120 per ounce, and the various grades cover the whole range of



Accurate control in the dispensing of diamond lapping compounds is afforded by a syringe with micrometer-action plunger
(Engis Ltd)



Right: A standard press is made to serve as a transfer feed press by the addition of this unit
(Turner Bros. Ltd)

This automatic polishing machine sprays compound on to the mop as the workpiece, mounted on a jig, slowly rotates
(B. O. Morris Ltd)

cutting and finishing processes for soft, hard and very hard materials.

Nylon is used for the moulded body of the dispenser, and for the threaded shaft of the plunger. Around the knurled nut that controls the action of the plunger is an annular groove in which registers the spigot end of a set screw that is mounted in the body, so that there is virtually no unwanted axial movement of the plunger. A removable nozzle is screwed on to the other end of the body, and it can be fitted to a freshly loaded body when all the compound in the first one has been used. In this way, none of the compound remaining in the nozzle is wasted.

Since the dispenser is intended for one-handed use, the knurled screw can be operated by the thumb, so that precise quantities of paste are delivered. Since the body is of translucent material and different grades of paste are of different colours, identification of the grade within is easy; an additional advantage of this translucency is that an operator is more likely to be impressed with the need for economy if he can see the plunger moving.

Automatic profile-polishing

Components such as metal beadings, fascia surrounds and window vent frames can be treated on the Morrisflex-Hammond automatic profile polishing machine recently introduced by B. O. Morris Ltd, Briton Road, Coventry. The jig on which an article must be mounted for polishing is specially shaped to the same profile as the article. This jig is, in essence, a flat plate with, underneath, a vertical flange round its periphery. On the top face is the quick-action clamp for holding the workpiece, and around the flange is wrapped a roller chain constrained to follow both the concave and convex edges.

Several pads are fixed at intervals around the lower edge of the flange. In operation, these rest on the polished work-

Replacing the cartridge elements in the gas filter does not involve breaking the pipe connections to the filter casing
(Alfred Bullows & Sons Ltd)

table of the machine and allow the jig to slide over it. A sprocket that projects from the surface of the table, with its axis vertical, meshes with the roller chain, and in operation causes the jig and workpiece to rotate slowly. Continuous engagement of the drive sprocket is assured by the presence of a pressure roller that bears against the back of the flange immediately adjacent to the sprocket. This roller retracts below the work surface between operations. Beneath the table are the electric motor for the drive sprocket, and the control system for the spraying of polishing compound.

The polishing head is adjustable to any angle, and an ammeter is incorporated that serves to indicate the pressure on the mop; floating polishing heads are available, for applications involving irregular outlines. Incorporated in the head is a spray gun for the polishing compound, and there is provision for varying both the spray timing and the quantity of compound delivered. Two or more polishing heads can be employed at a time, if required.

It is stated that the system is more suitable for batch production or where long, awkward workpieces are to be treated. The standard table size is 40 in × 30 in, but this can be extended by outrigger sections. Two sizes of polishing head are available, one with a mop 16 in diameter × 5 in wide, and the other 12 in diameter × 3½ in wide. Edge grinding instead of polishing can be carried out on this machine, by using an abrasive band attachment on the polishing head. Dust extraction equipment is available, to suit the requirements of the customer. B. O. Morris Ltd. are able to accept sample workpieces for test so that recommendations on treatment can be made.

Charcoal filters

Alfred Bullows and Sons Ltd, of Long Street, Walsall, have introduced a range of activated charcoal filters designed for use in compressed air systems where the presence of oil in the air stream is not acceptable. There are five capacities of filter in this range: 3 ft³/min; 10 ft³/min; 30 ft³/min; 60 ft³/min; and 120 ft³/min. The charcoal is supplied in the form of an expendable cartridge which has to be replaced at intervals; it is contained in a metal casing whose lid is sealed by an O ring.

The air inlet and outlet unions are respectively at the bottom and side of the casing, so that air connections do not have to be broken when a filter change is made. Brackets on the casing provide for four-point wall mounting. An average normal life of the cartridge elements is claimed of 1,000 to 1,500 working hours. It is also claimed that the filters remove not only all oil from the air but also the unpleasant smell of oil normally associated with air compressors and pneumatically operated equipment.

This hydraulically operated clamp, when released, automatically swings away from the workpiece to rest at 90 deg to its operating position
(Power Jacks Ltd)

Automatic hydraulic clamping

This small device is basically a rocker arm, pivoted in the centre, with a jack under one end imparting a clamping action on any object placed under the other end. Jacking, in this case, is done by a small hydraulic ram that is embodied in the casting on which the central pivot assembly is mounted. The pivot, however, is swivel-mounted so that the rocker arm, when not clamping, can be turned to a position at right angles to its working position, to increase the space available in the work area.

Both the swivelling movement and the clamping action are effected hydraulically, and both these movements are controlled by a common lever. Operation of this lever causes the arm to swing from its rest position to its clamping position and then to clamp; when the hydraulic pressure is turned off, the clamp is released and the arm swings back. These clamps are quick-acting and can be used singly or in series. They are each secured to a work surface by only two bolts. They are designated Newton Swing Clamps, and are manufactured by Power Jacks Ltd, Acton, London, W.3. Their overall length is 7 in, and the width is 3½ in; the maximum clamping force is 1,160 lb.

Rack clamp

Although the standard G clamp, and adaptations of it, are widely used in virtually all branches of industry, there are several drawbacks associated with this type of fixture, particularly in applications to welding processes and those done by unskilled labour. For instance, the length of the screw invariably is such that useful time is wasted in adjustment to accommodate components of different sizes. Again, when for convenience a small component is secured by a large G-clamp, side thrust occasionally causes the screw to distort. In addition to this, the screw threads may rust or be subject to weld spatter, and the wear and tear of abrasive materials.

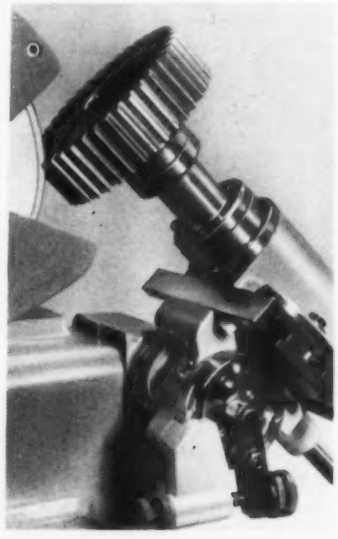
The Carver rack clamp was originally designed for use in welding and has been found suitable for many other types of clamping operations quickly and efficiently. Its fixed jaw is an extension of the rack, and the movable jaw carries a pin that rests in the selected position on the rack and also acts as a pivot for the final tightening of the clamp. Among the advantages claimed for this tool, in which the screw is short and well shielded, are a powerful grip without clamp distortion, and absence of the danger of weld spatter. Its components are cadmium plated for rust resistance. By virtue of its fine pitch screw a clamping force of over 1,000 lb can be applied, and the shortness of the threaded portion obviates bending or side play.

A degree of angular movement of the pad of the movable jaw enables it to grip securely on odd shapes, and, if desired, the clamp can be arranged to operate in reverse for use as a jack. It is also possible to use the clamp as a wrench. There is a choice of two sizes of clamps: one has 6 in capacity and the other 12 in; a heavy duty model is also available. The manufacturers are Carver and Co. (Engineers) Ltd, Eldon Street, Walsall, Staffs.

One of the features of the rack clamp is protection for the screw against weld spatter
(Carver and Co. Ltd)

Gear deburring

A semi-automatic machine, designated the D-Burr gear deburring machine, is being manufactured by Burrows and Smith Ltd, of Leicester, and marketed by Alfred Herbert Ltd, Edgwick Works, Coventry. In operation, the gear being treated is mounted on a freely rotating spindle and the grinding wheel, in the form of a worm, engages with the gear and simultaneously rotates it and removes the burrs.



There is provision for vertical, longitudinal and swinging adjustment in the workhead of this self-contained deburring machine; spur bevel, and helical gears, and sprockets, can be successfully treated
(Alfred Herbert Ltd)

The spindle on which the gear is mounted is embodied in a tilting workhead that has provision for vertical, longitudinal and swinging adjustments, so that spur, bevel and helical gears, and also sprockets up to as much as 12 in diameter, can be treated.

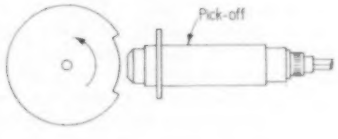
This workhead has a handle at its lower end, and the gear tilts towards the grinding wheel as the handle is lifted; a spring-loaded stop comes into operation as the gear

approaches the wheel, to slow the rate of tilting until, finally, a positive stop is reached. It is necessary, therefore, for the operator to maintain a constant pressure, with his right hand, on the handle, while deburring is in progress. Since the switch lever for the grinding wheel is spring-loaded to return to neutral when released, the operator's left hand has to be used to keep it depressed. Since both his hands are engaged, safety is assured. The grinding wheel is 8 in diameter by $1\frac{1}{4}$ in wide by $2\frac{1}{8}$ in bore, and its head is adjustable transversely. It is pre-formed according to the appropriate pitch and form of the gear to be deburred, and the claim is made that to discard a worn wheel is more economical than making an effort to re-form it, since one wheel is capable of deburring 100,000 teeth. As an example of the speed of which this machine is capable, it takes only 15 sec to chamfer both sides of a 30-tooth, 8 d.p., 20 deg pressure angle gear.

Electronic Microswitches

AMONG the items of equipment in the category of industrial control gear now available is a device termed the Cam Pick-off, which is manufactured by Servo Consultants Ltd, of 10 Bouverie Place, London, W.2. This device can be described best as an electronic microswitch. It is actuated by a moving part of the machinery to which it is applied, and it has the advantage that it does not come into physical contact with the part. Since the pick-off, which is a transistorized unit, has no moving parts, it can operate without adjustment for very long periods. Applications include automatic machinery, machine tools, batch counting and process control.

The unit is intended as a substitute for the more conventional arrangement of a pair of electrical contacts actuated mechanically by a cam. It can be actuated by a cam, rack or similar device made of magnetic material. The gap



between the end of the pick-off and the cam can vary between 0 and 0·030 in. for the "on" condition, and should be more than 0·25 in for the "off" condition. A response range from zero to 1,000 c/min is claimed, and the accuracy of resolution is said to be ±0·020 in, giving an angular accuracy of approximately 25 min of the arc obtained with a 6 in diameter cam.

Type 400 is intended to operate electronic equipment where relatively high output impedance is acceptable. The output voltage changes from one limit to another during 0·030 in transition of the cam edge, and the output impedance is 40 kΩ. The type 401 unit has been designed to operate electro-magnetic devices requiring more power than that obtained with the previously mentioned pick-off. Typical applications are relays, solenoids and counters. Warning lamps can also be operated directly by the unit, which can be used at a maximum rate of 75Ω with a supply of 10V. Another unit, type 402, is available and is intended primarily for operating fast electronic counters and logic stages requiring fast pulse rise times. The speed of transition from one output to another is substantially independent of the cam speed, and the rise time is 35 μsec. Its maximum load impedance is 40 kΩ.

The overall length of the pick-off is $6\frac{1}{2}$ in and the overall dimensions of its attachment flange are 2 in × 3 in. This unit can be operated from a 7 to 10 V d.c. power supply. Either supply rail can be earthed; alternatively, both can be left floating. The manufacturers state that the current consumption of the types 400 and 402 is 25 mA and that of the type 401 is approximately 200 mA. A Plessey Mk 4 three-way plug connector is employed with this instrument.

Factory Flooring

IN CERTAIN areas of factory floors, where heavy traffic or spilled corrosive materials damage the surface, maintenance is constantly a problem. To obviate these difficulties, a new flooring composition, called Epiflor, has been developed by Tretol Ltd, of The Hyde, London, N.W.9. It is a combination of special resins and aggregate which, it is claimed, will adhere strongly to all floors. This coloured, non-slip topping is applied as a $\frac{1}{8}$ in thick layer. It is resistant to chemicals, oils and acids, and has good abrasion resistance as well as being capable of withstanding hard wear. Tretol Epiflor can be laid easily by firms' maintenance staffs. Further technical details can be obtained from the manufacturers, whose address is given above.

Heat Treatment

MANY requests for general information concerning the heat treatment of iron and steel are received by the National Bureau of Standards, of the U.S. Department of Commerce. Therefore, a monograph, No. 18, has been prepared to answer these enquiries and to give, simply, a working knowledge of the basic theoretical and practical principles involved in the heat treatment of iron and steel. The effects of various treatments on the structures and mechanical properties of these materials are described. Some theoretical aspects and technical details are discussed only briefly, or omitted entirely, to avoid confusion owing to over complication. The monograph also contains a complete list of all current structural, tool, and stainless steels and their recommended heat treatments.

Its title is "Heat Treatment and Properties of Iron and Steel", and it is by Thomas G. Diggis and Samuel J. Rosenberg. The monograph can be obtained, price 35 cents, from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Orders from outside the United States must be paid for in American currency and should include an additional quarter of the publication price, to cover mailing costs for dispatch overseas.

AUTOMOBILE ENGINEER INDEX

An index to Volume XLX—January to December 1960—is available, price 6d, by post 8d. Binding cases and index can be supplied separately, price 7s 6d, by post 9s. The remittance should be sent to Dorset House, Stamford Street, London S.E.1.

We shall be pleased to undertake the binding, the cost being 25s per volume, including supplying binding case and index and the return postage on the completed volume. The complete issues should be sent addressed: Associated Iliffe Press Ltd, Binding Department, 4/4a Iliffe Yard, London, S.E.17, with a note of the sender's name and address enclosed. A separate note confirming despatch, together with remittance, should be sent to the Publishing Department, Dorset House, Stamford Street, London, S.E.1.

TAPE-CONTROLLED PIPE BENDER

Operating on a Punched-Tape Programme, the American "Bend-O-matic" Machine Produces Exhaust Pipes from Straight Tubing at the Rate of Six Accurately Positioned Bends per Minute

SYSTEMS of numerical control for drilling, milling, and profiling machines are now widely available, and their employment has extended from the laboratory or tool room to the production shop. As regards production, these systems have proved to be of great value where an extensive range of components of basically similar type has to be produced in batches of different quantities. In such cases, the down-time occasioned in the changeover of tooling and setting between batches is likely to become a major factor affecting economical operation.

An American company, the Nu-Era Corporation which supplies exhaust pipes for passenger cars and trucks, was faced with this specific problem, and to meet it the General Machinery Division of the Baldwin-Lima-Hamilton Corporation designed and developed the novel "Bend-O-Matic" machine here illustrated. This is claimed to be the first application of numerical control to a pipe-bending machine.

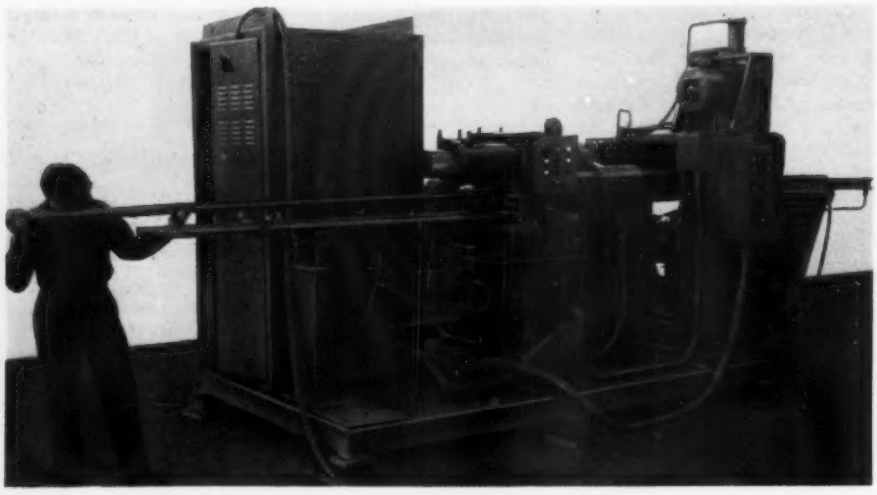
A complete programme of operations for bending an exhaust pipe is punched on a standard paper tape; commonly about 18 in is required. Programmes for all the range of different pipes to be produced are coded and held in a storage unit. In addition to the three major motions—linear advance, polar orientation, and angular bending of the tube—the following auxiliary functions can be programmed:

1. Select one of ten dies
2. Position one of ten dies
3. Cut-off
4. Operator's instructions
5. Cycle stop
6. Polar clamp—On
7. Polar clamp—Off
8. Headstock clamp—On
9. Headstock clamp—Off
10. Wiper block—On
11. Wiper block—Off
12. Flattening die—On
13. Flattening die—Off.

Inserting a punched-tape programme for a complete operational cycle into the tape reader. Tapes are prepared on a standard tapewriter

Except for loading and unloading, operation of the machine is completely automatic. To produce an exhaust pipe, the machine operator selects the appropriate tape programme, inserts it in the tape reader incorporated in the machine, loads straight tubing of the required diameter and wall thickness into the machine, depresses the starting button and, when the cycle is completed, unloads the bent pipe. Actual cycle time on the prototype machine illustrated is approximately two minutes. Precise bends are made at the rate of 6 per minute but on subsequent models the performance will be slightly improved to a rate of about 6½ bends per minute. The three main functions performed by the machine are (1) move, position, and bend the pipe; (2) move, position, and flatten the pipe; and (3) position the pipe and cut off.

Although the machine will accept straight tube in lengths



Loading straight tubing, stocked in 16 ft lengths, into the "Bend-O-Matic" machine. After bending and flattening, the pipe is cut to length automatically by an incorporated saw, completing the cycle

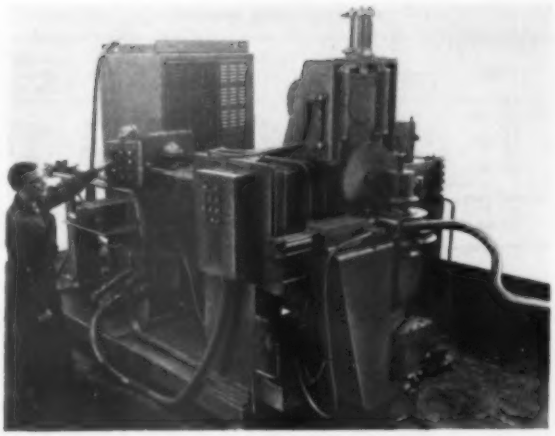
up to 36 ft, the arrangement, in this instance, is to hold stock in cut lengths of 16 ft for convenience in handling, storage, and stock control. It has been found that exhaust pipes for virtually all American passenger cars and trucks are 8 ft or less in length and, consequently, two pipes can be produced from each stock length of tube. The cut-off operation is programmed to saw the stock tube, following bending and flattening operations.

Incidentally, only four basic sizes of tube—diameter and wall thickness—are needed to cover the requirements of the entire current range of vehicles. In all, about 750 different exhaust pipes are produced. Overall dimensions of the machine are 8 ft × 10 ft × 6 ft and it can be accommodated with adequate space for the operator to load and unload, provided 16 ft stock is used, in a floor area of 1,500 ft².

Most machine tools require only a single type of servo drive for all motions. On the "Bend-O-Matic" machine, however, there is a need for two types of drive. Direct current electric motors are used for the linear feed and the polar rotation of the pipe, but a hydraulic drive is employed for the bending motion in order to provide the necessary torque in the small space available on the machine. The first motion, linear feed of the tube, requires a high positioning speed of 50 ft/min. This is approximately three times as fast as the highest positioning speed of a conventional machine tool motion.

A positioning accuracy of ±0·05 in is demanded in this operation, so special precautions have been taken to obviate the large overshoot that could be expected in such high-speed positioning movements. Polar rotation of the tube, the second motion, is, as regards positioning, relatively straightforward. Interlocks are provided to maintain constant accuracy in this movement.

For the third motion, bending of the tube, the high torque required dictated the use of a hydraulic drive. Commonly, a proportionally controlled servo valve is recommended for such drives in machine tool applications. In this instance, since the accuracy of the bend is not closely limited—actually ±1·8 deg—a two-speed servo valve is employed in order to keep the drive as simple as possible. This makes available a fast movement with a slow approach speed.



A fully bent exhaust pipe held by the machine, on the completion of the sequenced automatic cycle, ready for off-loading

On the prototype machine, input data can be set up in the control equipment by manually operated switches. Normally, however, it is set by means of the standard one-inch wide, punched tape, such as is used throughout the machine tool industry. Tapes may be programmed on one of a number of standard tapewriters and the data-handling apparatus is integrated with the control functions so that no delay need be experienced during the input of new information. While the machine is operating from previously supplied instructions, new data can be stored for a succeeding programme. In operation, while one portion of the machine is performing its programmed function, another part is being reset ready for the next sequenced function.

POWDER-WELDING PROCESS

A New Method for the Manual or Mechanized Deposition of Stellite Heat-resistant, Corrosion-resistant, and Wear-resistant Hard-facing Alloys

REGARDED rather as a complementary addition to than a rival of existing methods of hard-facing, including spray fusing, sprinkle fusing, and gas welding, this new process is particularly suitable where a relatively thin overlay of hard metal is required. Recommended thickness of the overlay is from $\frac{1}{32}$ in to $\frac{1}{16}$ in, with a preferred maximum deposition of $\frac{1}{8}$ in thick in a band up to 2 in wide. Best results are obtained where the section of base metal is thin; $\frac{1}{4}$ in to $\frac{3}{8}$ in being the optimum thickness, but weldable material thicker than $\frac{3}{8}$ in can be handled satisfactorily. Most rapid coverage is obtainable on stainless steels.

Outstanding advantages of the process, claimed by Deloro Stellite Ltd, of Highlands Road, Shirley, Solihull, Warwickshire, are that it is simple to operate, is twice as rapid as arc welding, four times as fast as gas welding, and involves the minimum risk of work distortion. Spraying and fusing are performed in a single operation, the deposit is relatively smooth and needs little finishing, there is low dilution of the deposit from the base metal, and powder loss is negligible. As with all powder-depositing techniques, it is not recommended for building up a square edge or shoulder, and sudden changes of section should be avoided.

Equipment required is two bottles of acetylene, one bottle of oxygen, one bottle of argon, a balanced-pressure powder hopper, a No. 50 spraying pistol fitted with a special powder-weld attachment, an argon supply changeover valve, and the necessary connecting hoses. Both the hopper and the pistol are manufactured by the Schori Division of F. W. Berk and Co. Ltd. Oxygen and acetylene gases are fed directly from the bottles to produce the heating flame, independent of the powder feed. In order to convey the powder without oxidizing either the powder or the hard-facing deposit, argon is used as the conveying gas. Powder is supplied from the standard powder hopper, as is normally used in metal spraying. Taken together, these items provide powder-welding apparatus that is exceptional, since powder supply and oxy-acetylene flame conditions can be varied infinitely, and independently of each other, to suit the work.

The first essential in preparing the component for hard-facing by this technique is that the surface should be cleaned

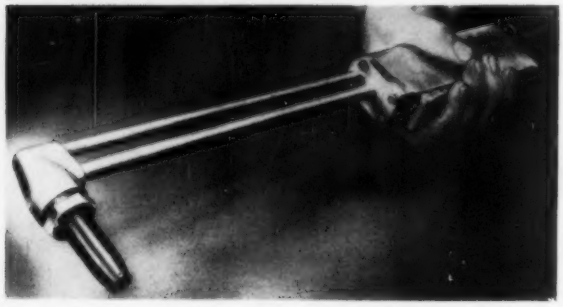
DELORO STELLITE POWDERS

Powder	Approximate Composition								Deposit Hardness DPH	Melting Temp. deg C
	Co	Ni	Cr	W	C	B	Si	Fe		
Cobalt base										
SF. 6	50	13	19	8	1·0	1·5	2·5	—	425	1,170
SF.12	52	13	19	9	1·0	1·5	2·5	—	500	1,140
SF. 1	45	13	19	13	1·0	2·5	3·0	—	600	1,125
SF.20	42	13	19	15	1·5	3·0	3·0	—	750	1,050
Nickel base										
SF.50	—	77	10	—	—	1·5	5·0	4·0	550	1,050
SF.60	—	70	15	—	—	3·0	5·0	4·5	750	1,020

of all traces of oxide and grease. This can be satisfactorily achieved by various machining operations and additionally or alternatively by degreasing. It is not necessary to grit or shot blast the surface, as is commonly required for metal spraying. The preferred preparation is a machined, shallow recess. As the powder is deposited to form a molten pool, the walls of the recess serve as a natural guide, thus assisting the welder, whose aim should be to fill the recess completely.

Recesses should preferably be not more than 2·0 in wide and the deposit should finish not more than 0·1 in thick. A thickness range of 0·030 in to 0·080 in may be regarded as the optimum. The powder feed, after the lines have been purged with argon, is first adjusted by manipulation of the control valve at the base of the powder hopper. In controlling the coating thickness, the intensity of the flame used must be regulated in association with the rate of advance of the torch over the work being treated and also the angle at which the work is set to receive the powder flow.

Schori Model 50 pistol incorporating the powder-weld adaptor



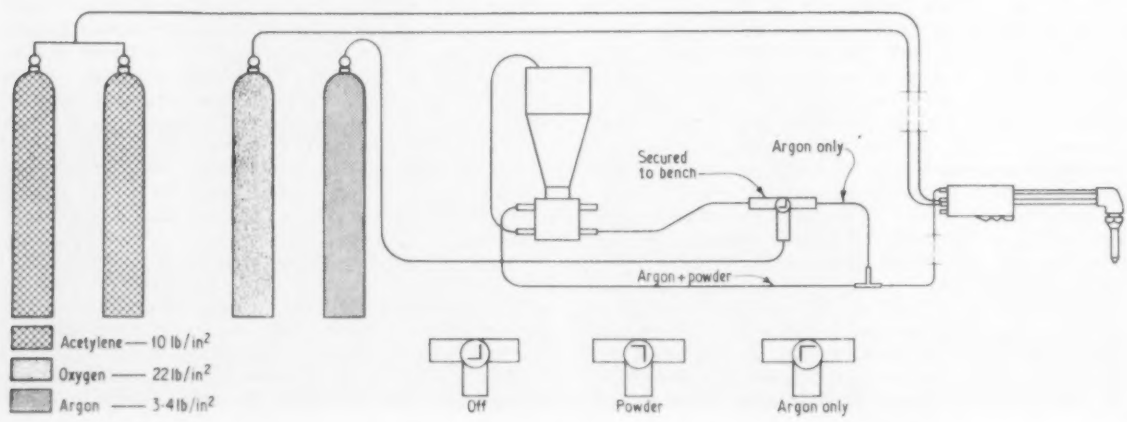
Fusing temperatures and data on Deloro Stellite powders suitable for deposition by the Schori powder-welding equipment are shown in the accompanying table. The powder-weld process has less effect on the base metal than the more familiar oxy-acetylene welding process using Stellite rod, since the maximum local temperature in the area of deposition is very much lower. It is customary to apply hard-facing overlays to components that are in a normalized or annealed state. The conditions of service, however, may demand the protection of components composed of special steels that are capable, after heat treatment, of considerable hardness and strength. In such instances, the actual hard-facing should never be attempted on the material in the hardened condition. The component should, therefore, be annealed before hard-facing.

The area to be protected must be raised to a temperature of 600 to 700 deg C prior to commencing the actual deposition of metal. A limiting factor in assessing the pre-heating temperature is the oxidation effect of this preheat on the steel surface. The best type of material to be hard-faced by this method would be one of stainless or oxidation-resistant steel. For this reason, metal up to $\frac{1}{2}$ in thickness is better suited to the technique than thick metal of irregular section. The relatively high and uniform preheat demanded for the technique is a safeguard as regards local stresses during welding. It is primarily for this reason that distortion effects on components hard-faced by this method are reduced to a minimum.

Subject to the requirements of service and the grade of Stellite chosen, the hard-faced component may be heat treated (by oil quench, not water quench) to obtain the required properties in the base metal. The actual hard-facing deposit will be unaffected by this heat treatment. In the majority of cases, the only heat treatment necessary after powder welding is slow cooling in lime or kieselguhr, or a stress-relieving time and temperature cycle dependent on specification of base material and metal thickness. Powder weld deposits may be left in the "as welded" condition or finished with conventional carbide tools or by grinding.

Powder welding with Stellite alloy powders is suitable for protecting engine valves and valve seats against combustion heat and lead corrosion and for providing wear-resistant surfaces on push-rod ends, tappet faces, rocker pads, thrust buttons and similar items. The process can readily be mechanized, by the provision of relatively simple positioning and traversing equipment, in order to reduce the time and skill currently required to hard-face such components by using the more conventional oxy-acetylene welding method.

Diagrammatic layout of Schori equipment for the deposition of hard-facing alloys. Details show the three positions of the bench-mounted control cock



COMPUTERS IN TRANSMISSION DESIGN

By S. E. STAFFELD*

Their Application for the Analysis of the Drive Line Vibration Characteristics

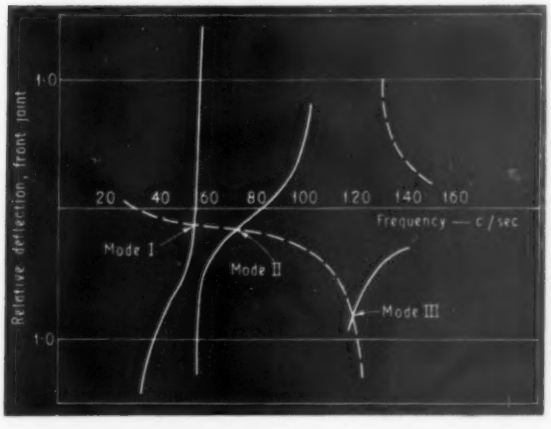
COMPUTER analysis of automotive drive trains has helped to deal with the many, and ever increasing, combinations of power plants, transmission extensions, and propeller shafts. In advanced design programmes, the computations have been useful in picking out the drive-line arrangements most likely to have inherent vibration problems, so that they could be scheduled for test as early as possible to allow plenty of lead time for development. Direct applications have been made—destructively high stresses reduced by modifications to increase the tuning ratio—but the benefits of being able to see rapidly the effects of the variations of a length, weight, or stiffness, and of knowing what phenomena can and cannot be explained by the given set of assumptions, are probably of the greatest value.

All American cars of conventional layout have a drive train with certain basic features, Fig. 1. The engine transmits its power through a clutch or torque converter, a transmission and transmission extension, to the propeller shaft with universal joints at each end, and thence to the axle carrier. Flexibility in the torque converter housing, transmission extension and propeller shaft gives rise to two types of vibration phenomena.

Unbalance in the propeller shaft excites a first order vibration of the system. The unbalance, of course, may be anywhere in the shaft, although if it is at the centre it is more serious than at the end. First order vibrations excited by drive-lines mostly occur at higher speeds, in some cases beyond the top speed of the car. They can be very serious and, at the critical speed can cause failure of the propeller shaft, transmission extension, or torque converter housing.

The universal joints generate second order forces and moments, the magnitudes of which are proportional to joint angularity. Since these cause vibration at a frequency of two per revolution of the propeller shaft, vibrations caused by these forces take place at car speeds in the normal driving range. The problem in this case is not stress but noise. The vibrations are transmitted through the engine mountings and suspension to the body shell. There are usually at least four of these periods and some, unpredictably, are louder than others.

Fig. 2. Curves plotted to determine resonant frequencies of vibration



It has been usual to think of these phenomena in terms of the so-called propeller shaft critical speed, that is, the resonant frequency of the shaft with both ends attached to fixed universal joints. This vibration frequency of the shaft as it is mounted in a balance machine is easy to measure and to relate to length, diameter, and metal thickness. But this approach did not give much more information than that all drive-line frequencies would rise and fall with that of the propeller shaft. There was, of course, a considerable body of experience to draw on in formulating and developing a transmission line design but there were still surprises. An analytical approach, made possible by the digital computer, has enabled some of the surprises to be obviated and predictions of design value to be made.

Computer Analysis

The object of the computer analysis was to take into account the important facts neglected by the propeller shaft critical speed approach. It was clear that flexibility in the power plant and in the axle carrier are important and that, where possible, the input to these components should be derived from drawings and experimental data, with a minimum of manual reduction. It was known that the principal axes of mass and of flexibility are close to horizontal and vertical in all components, and that vibration could, therefore, be considered as the vector sum of two independent planar vibrations. Damping, although significant, was neglected, with the feeling that it would not greatly affect resonant frequency values and their mode shapes.

The power plant and the propeller shaft were considered as non-uniform beams, the mass and flexibility of which varied along their length. These beams are assumed to be composed of increments, each consisting of a flexible, weightless beam with its mass and moment of inertia concentrated at one end. Since the increments may be small and the mass distributed as continuously as desired, no inaccuracies are introduced. Considering the increment to be part of a beam executing linear planar vibrations, and, given flexibility, length, mass, and moment of inertia, we can express the four variables, displacement amplitude, angular amplitude, shear force amplitude, and bending moment amplitude, at one end in terms of the other end. This is done by means of four simultaneous equations for each segment into which the beam is divided. Of course, with many increments, to express one end of the beam in terms of the other algebraically would be extremely laborious, and even numerically requires much computation. This, then, is where the digital computer comes in.

A scheme is devised where the computer operates on the

* *Chrysler Corporation, United States of America.*

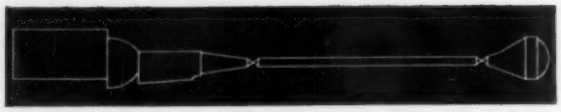
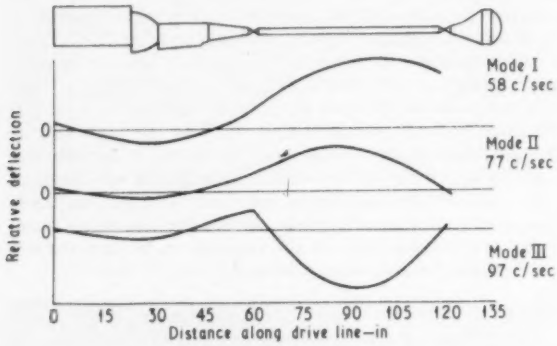


Fig. 1. Drive-train arrangement typical of that used in American cars

constants, such as flexibility and length, of the first increment, to form the coefficients of its simultaneous equations, which it then stores; next, it forms the coefficients of the second, operates on those of the first to form a new set which relates the left-hand end of the first increment with the right-hand end of the second, forms the third set, and forms a new set relating the left-hand end of the first increment with the right-hand end of the third increment; this repetitive process continues until the last segment of the beam is reached and the conditions at one end of the complete beam are expressed in terms of those at the other.

Fig. 3. Deflection curves, showing the vertical modes of vibration



This gives four simultaneous equations in eight variables. To solve these equations we need four more equations, which will constitute the boundary conditions. In the case of the power plant, both shear and bending moment are zero at the front end, because it is not connected to anything. At the rear end, bending moment must be zero because of the universal joint. If we then make the amplitude of the shear force arbitrarily equal to +1,000 lb, all the variables can be solved. This process is repeated for each frequency.

So far as horizontal vibration is concerned, the axle carrier may be considered as perfectly rigid, so that the displacement amplitude of its nose is zero. Therefore, for the right-hand end of the propeller shaft, the displacement and the bending moment, because of the universal joint, are zero. At the left-hand end, the bending moment is zero and the shear is assumed to be −1,000 lb.

The amplitude of motion of the power plant and propeller shaft at the first universal joint are plotted against frequency. Where the curves intersect are the frequencies at which the amplitudes of motion of the shaft and power plant are equal. Since this is the true final boundary condition for both, it is the frequency at which they resonate together. The choice of any arbitrary force would result in the same frequencies and, since damping has not been considered, the amplitudes of the points of intersection have no real significance.

In one sense, this is nothing more than a graphical solution of two equations, one relating force and displacement at the end of the transmission extension, and the other relating force and displacement at the front end of the propeller shaft. This could have been done on a computer with the output as resonant frequencies, but the graphical method contributes to understanding the phenomena. Under the propeller shaft critical speed theory, it is assumed that the power plant is infinitely stiff and massive. If this were so, the engine amplitude curve on the drive-train resonance plot would be a horizontal line through zero deflection, and there would be one resonant frequency where the propeller shaft line crosses it.

Where the axle carrier is not rigid, there are provisions in the programme for replacing the boundary constraint $y_n = O$, with $V_n = ky_n$, where k is a tabular function of frequency, which has been derived from experimental data, and V is the shear force amplitude. This is shown in Fig. 2. In addition, it is possible to insert flexible mountings at any point in either member. This has application in problems such as that of intermediately supported propeller shafts, and has been used to confirm the unimportance of engine mountings so far as the critical speed problem is concerned.

Once the resonant frequencies have been determined, a second part of the computer programme can be used to compute values of the forces and displacements for those frequencies at each of the increments. This permits us to draw mode shapes and to locate the points of high relative force and bending moment. Typical mode shapes are shown in Fig. 3.

The input is prepared almost entirely from detail drawings. As part of the preliminary chassis design procedure, the transmission components are divided into increments, and masses and flexibilities are computed from measured areas and area moments of inertia—an exception is the torque converter housing, which is less a computation than an estimate based on measurement and experience. All this information is then entered into the computer, the constants for each increment being on a separate input card. With this system, changes in length can be made by adding or removing cards, and the line-up of components is simply a matter of stacking appropriate decks of cards.

As it stands now, this programme will give us only relative, not absolute, amplitudes. To take damping into account we develop the concept of tuning ratio as follows. The propeller shaft, being essentially a simple tube with no

Fig. 4. This diagram shows that there is a relationship between the ratio of propeller shaft critical speed: power plant resonant frequency and the amplitudes of the first and second resonances

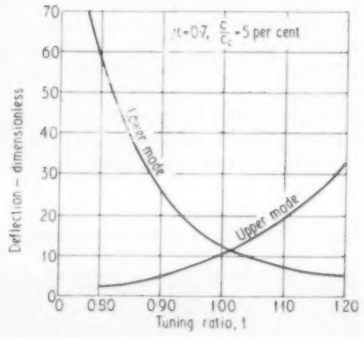
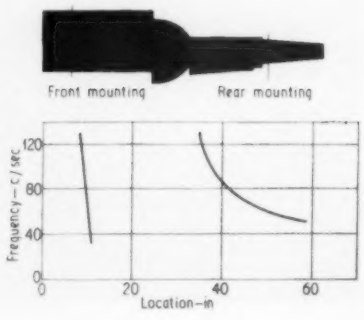


Fig. 5. Location of the vibration nodes at different frequencies. This information is particularly useful in connection with the avoidance of the transmission of noise through the engine mountings



contained fluid or rubbing parts, contributes an insignificant part to the total damping in the drive-train: the major part is contributed by the engine and, to a lesser extent, the carrier. Considering only the propeller shaft and the power plant, the problem is to gain some idea of how to make the damping that exists contribute most to the reduction of amplitudes at resonant frequency. It can be shown, Fig. 4, that there is a relationship between the ratio of propeller shaft critical speed : power plant resonant frequency and the amplitudes of the first and second resonances of the system.

The output of the programme can be varied to suit its purpose. In addition to locating the resonant modes, Fig. 2, mode shapes at the resonant frequencies can be plotted in terms of deflection, Fig. 3, or equally well in terms of shear force or bending moment along the drive train. Fig. 5 is particularly useful for an understanding of noise phenomena. Since the noise due to second order vibrations is transmitted through the engine mountings, it will be proportional to the distance of the mounting from the vibration node at the resonant frequency. This is a significant factor in design.

Deva Metal

ONE of the exhibits that will be shown at the Engineering, Marine, Welding and Nuclear Energy Exhibition, at Olympia, from 20th April to 4th May, is a permanently self-lubricating metal. It is termed Deva metal and is manufactured in Great Britain by Universal Metallic Packing Co. Ltd, of Beehive Works, Edderthorpe Street, P.O. Box 237, Leeds Road, Bradford 3. The material, which is a homogeneous and non-porous solid, is made by compacting natural or colloidal graphite powder with primary or alloyed metal powders. Its self-lubricating properties are said to be maintained, irrespective of wear, over a wide range of temperatures. This quality, it is claimed, is obtained by virtue of the formation of a graphite film on the contacting metal surfaces, as they rub together. The manufacturers state that the metal can withstand high temperatures and PV factors.

Various grades of bronze, brass and iron are used as the metallic constituent, so the range of materials covers operating temperatures between − 330 deg F and 1,100 deg F. Deva metal is easy to machine and, despite its graphite content, its Brinell hardness value is between 50 and 82, and its compressive and tensile strengths are respectively from 12 to 18 tons/in^2 and 4 to 7·5 tons/in^2. The coefficients of expansion quoted are between 9×10^{-6} and 11×10^{-6} per deg F, and the coefficients of friction vary from 0·05 under favourable conditions to 0·3 under very unfavourable conditions. The material is stated to have been used successfully under dry conditions at PV factors of more than 100×10^3 lb/in^2 per lineal ft/min and it is also claimed to perform well in the presence of water, gases and vapours, which are absorbed by the graphite and assist in establishing a lubricating microfilm between the contacting metals.

Testing Crankcase Oils

A SYMPOSIUM on the subject of the engine testing of crankcase lubricating oils is to be held by the Institute of Petroleum at the Hotel Metropole, Brighton, from 17th to 19th May, 1961. Among the objects of the symposium is to inform industry and other interested parties of the work carried out by the various Institute of Petroleum Committees in connection with the development of standardized test procedures for crankcase lubricating oils. In addition, the symposium will include a survey of the work carried out on engine testing and lubricating oils by Continental and American organizations. It is also intended to survey the requirements of the British, American and European armed forces and navies, as well as those of automobile and diesel engine manufacturers. Finally, it is hoped that, by discussion of these aspects, it will be possible to decide upon the action necessary to achieve better co-ordination of all efforts.

Among the contributors are members of General Motors, Chrysler and Ford of America, as well as some from the Continent of Europe. It is important, therefore, that representatives of the British industry contribute so that their views may be made equally widely known. The cost of membership of the symposium is £6, for which one set of pre-prints is supplied and members can attend an informal but official dinner on 18th May; light refreshments are also provided during the meetings, and there will be, for members, a discount of 25 per cent on the cost of one copy of the proceedings when published. Registration and hotel booking forms and copies of the programme can be obtained from the Institute, 61 New Cavendish Street, London, W.1.

Planning Chart

A SIMPLE mechanically operated wall chart, termed the Dia-Plan, is obtainable from Badenia Calculators Ltd, 72 Red Lion Street, London, W.C.1. Its dimensions are 22 in × 24 in, and it is constructed of aluminium. A graph sheet is clipped to the chart, and the scale can be typed on a detachable paper strip which slips into an indicator bar on the side of the chart. Along the base is a series of 28 reels, around which pass coloured ribbons. Variations of the quantities represented in the columns are indicated by manual rotation of these reels, which move the ribbons up or down in the columns above them.

At the end of each charting period, the location of the ends of the ribbons, and the date and other information are marked on the graph paper, which can then be filed for later planning and comparison operations. A transparent cover protects the chart against dust and also prevents accidental movement of the control reels at the base.

The recently introduced Dia-Plan chart is extremely easy to operate

New Cold-Forging Press

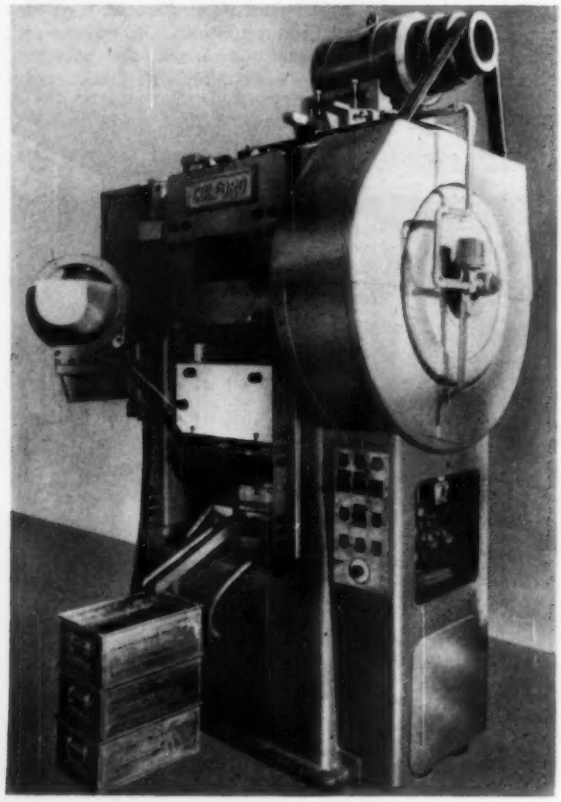
A British-Designed and Built Press, Exerting a Working Pressure of 200 Tons, 30 Deg Before Bottom Dead Centre, Specially Developed for Rapid Stroking and Multi-station Tooling

A BRIEF reference to this press, the Colforg, Type P 300, was made in a recent issue.* It constitutes one unit of the complete range of machine tools and equipment for cold forging steel components now made available by Cold Forging Ltd, of Hanworth Road, Sunbury-on-Thames, Middlesex. Designed specifically for cold-forging operations, it was first demonstrated at the Machine Tool Exhibition at Hanover last autumn. Outstanding features of the press are its structural rigidity, well-supported ram, ease of tooling changeover, and operational versatility.

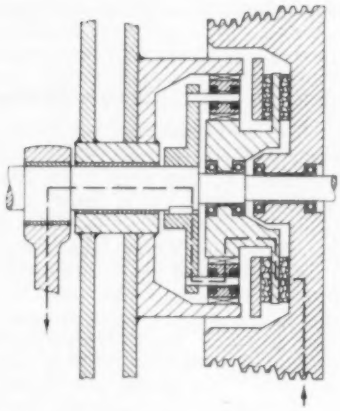
Conservatively rated to produce a working pressure of 200 tons at 30 deg before bottom dead centre, the press is capable of forging a wide variety of parts differing in size and weight. Particularly, it is suitable for the use of multiple tool units and can withstand substantial eccentric loading. With multi-station tooling and automatic work transfer, up to eight progressive forging operations can be performed each stroke, and automatic loading and unloading equipment can be provided. Such tooling set-ups are designed as complete units that can be pre-set in the tool room ready for rapid changeover between batches of work.

* *"Automobile Engineer", December 1960.*

Colforg Type P300 press with eight-station tool and automatic feed



Epicyclic reduction gear in main drive to the crankshaft (Diagrammatic only)



The press frame is a robust, welded steel structure, fabricated in sections and tied together by four vertically arranged pre-stressed tie-rods. Internally the sections are braced to resist lateral deflection. This design ensures complete stability and insignificant stretch, despite the relatively low weight of the framing.

To maintain a high degree of dimensional accuracy in continuous operation requires not only extreme rigidity in the machine structure but also maximum accuracy and freedom from "play" and "yield" in the various working parts of the machine. An example of the care taken to ensure this is furnished by the ram slides. These are exceptionally long, extending down below the horizontal working plane of the tools to ensure complete control. They are also carried above the level of the pivot point of the connecting rod, and are fitted with wedge-type adjusting devices to enable all slack to be taken up. Such a design permits eccentric loading of the press without causing uneven lateral pressure on the tools.

An overhead-mounted 20 h.p. motor drives the flywheel through a three-step, multi-vee belt drive to provide stroke rates of 60, 75 and 90 per minute. The crank is engaged through a clutch which is of the pneumatic-setting, spring-release type. Mounted on the opposite end of the crankshaft, the brake is of the spring-setting, pneumatic-release type. Controls for these units are electrically interconnected for safety reasons in event of pneumatic failure. Between flywheel and crankshaft a reduction of rotational speed is provided by a special epicyclic gear. The line drawing of this unit is merely diagrammatic. Actually it employs double-helical gears throughout, and is remarkably quiet in operation. It is claimed to be the first application of this type of drive to a power press, and affords a number of advantages:

1. Rapid braking of the press is improved since the moment of inertia is considerably smaller than that of more conventional types. This contributes to quicker control of press operations and to quicker reaction to safety devices
2. Compact design of the flywheel and axle

3. Smooth and silent operation
4. Complete enclosure of the gears permits the continuous circulation of lubricating oil, and prevents the ingress of dust or dirt
5. Safety guards or coverings are unnecessary as there are no other exposed moving parts
6. Dimensions of the gear unit can be smaller, due to the torque being distributed between three planet gears.

The capacities of the flywheel and motor are such that a high amount of energy per stroke is available; such as is necessary for extrusion operations. Large bronze bearings support the crankshaft, and the short connecting rod is articulated to the ram by means of a ball joint. Ram height is adjustable by a worm drive which screws one element of the ball joint into the connecting rod. Adjustment is effected manually on machines built for the continuous production of a single component but a separate motor drive is provided on presses for general use on batch production. The weight of the ram is counterbalanced by four springs.

Of the fail-safe type, the pneumatic system incorporates modern electrical apparatus to prevent any of the controls from being actuated in the event of a defect. Owing to the versatility of this press, it was necessary to adopt an extremely flexible safety system. The control system is of the low-voltage type for obvious reasons, and terminates in a jack box. This box may contain any desired number of jacks—normally six—all of which are connected in series.

Safety devices, therefore, are of the closed-circuit type, usually in the form of micro-switches. These are actuated by the various safety trips which come into action in the event of failures such as tool fracture, feed defects, or ejector blockage. The switches are connected to the jacks, which are then plugged into the box, and any sockets not used are short-circuited. Whenever a safety device comes into action, however, the pneumatic release is instantly tripped and the machine is stopped within 10 deg of its cycle of rotation.

In the event of the tool jamming at the bottom of the stroke, equipment is provided whereby the press can be operated very slowly by hand in order to release the tool. This takes the form of a small gear wheel which can be engaged with the toothed wheel attached to the flywheel, the gear then being rotated by hand with a long-shafted key.

Specially designed ejector mechanism is operated by a cam on the main crankshaft. The cam can be easily and quickly changed, which facilitates a variable control of the ejector stroke and time cycle. An adjustable threaded connector in the main linkage arm of the ejector system makes possible a variable operating height of the ejector. The main shaft is also extended to provide a positive auxiliary drive for various cam-controlled feeder mechanisms.

SPECIFICATION

Type	*P* 302	*P* 300
Working force, 30 deg before b.d.c.	400 ton	200 ton
Strokes per minute	45, 60, 90	60, 75, 90
Main motor	48, 45, 75 h.p.	20 h.p.
Width between uprights	28·5 in	23·5 in
Stroke	5 in	4 in
Max. ram adjustment	0·75 in	0·39 in
Max. distance, bed to ram	19 in	17·75 in
Bed area	28 × 31 in	23 × 23 in
Ram area	20 × 29 in	23 × 27 in
Ejector stroke	2 in	2 in
Overall dimensions	9 × 4·3 × 13·5 ft	7 × 4 × 11 ft
Weight, approx.	20 ton	11 ton

All important bearing points—the main bearings, connecting rod bearings, ram slides, and the main bearings in the ram—are automatically lubricated by a motor-driven pump system which feeds oil to the bearing points at correct, metered rates through individual pipelines. All other bearing points of the machine are lubricated through grease nipples. Both the lubrication system and the pneumatic supply units are mounted on the top of the machine.

The main driving motor of the machine, which is electrically coupled to the oil pump motor, is started by an automatic star-delta switch which is controlled from the main cabinet attached to the right of the machine. This includes the necessary controls for selecting automatic and manual operation, while on the operating panel on the right-hand front side of the machine are mounted the push buttons for selecting single-stroking, inching, normal operation, and stop. The entire panel is supported on resilient, anti-vibration mountings. Incorporated in the control system are a number of safety devices that effectively prevent any damage occurring in the event of faulty operation or overloading. All British official safety regulations for power presses are fully satisfied.

A larger model of this press, designated P 302, has a working force of 400 tons. The technical specifications of the two models are summarized in the table on this page.

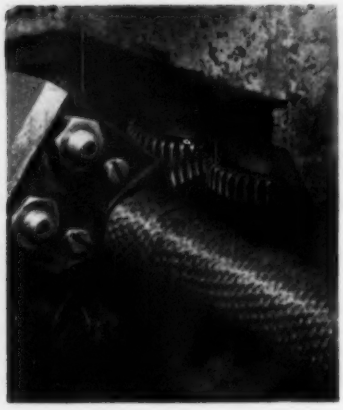
Machine Life Finance

AMONG the problems with which manufacturers, large and small, are faced is the financing of tooling programmes. Hitherto, these have had to be financed either by introducing permanent capital or by entering into a hire-purchase agreement. The latter agreements have been generally on a flat rate basis and transactions limited mostly to periods of three or four years. A new method of financing is described in a booklet entitled "Machine Life Finance", issued by Engineering Finance Ltd, one of the United Dominions Trust group of companies.

In normal cases, the equipment itself is the only security, and the finance charges are calculated on the reducing balance outstanding, and at an annual rate linked to the bank rate. Among the advantages of the scheme are that an expensive tooling programme can be undertaken without the introduction of permanent capital and the associated liabilities. Moreover, there is no need for registering any charge, and the firm's bank or other credit lines are unaffected. The arrangement should be of particular assistance in that it enables re-equipment to be undertaken when it is most convenient: for example, a programme could be implemented that otherwise might have to be postponed owing to restrictions in departmental capital allowances.

Payment for the new machinery can be made out of retained earnings and spread over a long period. The terms can be varied to suit the customer's book-keeping arrangements, and the initial payment is a matter for negotiation in each case. Investment and depreciation allowances can be claimed, and there are no legal charges or stamp duties.

A hire-purchase agreement is used, so the right to surrender the equipment can be exercised at any time. A firm surrendering in this way will be liable for any difference between the outstanding balance and the price for which the equipment can be sold, but will have the opportunity of collaborating in respect of its disposal. Also, the contract can be paid up in full, without penalty, at any stage. The arrangements do not apply, however, to vehicles or to industrial equipment with a high rate of depreciation. Copies of the booklet can be obtained free of charge from Engineering Finance Ltd, 29 Pall Mall, London, S.W.1.



FINNED TUBES

Helically Wound, Continuous-fin, Heat-transfer Tubing of Ferrous or Non-Ferrous Metals, for Heating, Cooling and Air-conditioning Equipment

IN many fields of industry the currently higher standards of thermal efficiency and operating efficiency increase the demand for heat-exchange equipment. On road vehicles, heating and demisting apparatus, engine coolant radiators and lubricating oil coolers are common. Combustion heaters, air-conditioning apparatus and refrigeration plant are used for passenger and load-carrying transport vehicles, particularly in areas subject to either one or both extremes of climatic conditions. Increasing interest is being shown in air-conditioning schemes for passenger cars and, in the future, such equipment may become a fairly common requirement in certain export areas.

An important component item in much of the equipment intended for use on road vehicles is finned, heat-transfer tubing. To meet current and possible future requirements, the Key-Leather Co. Ltd, of 5 Urswick Road, London, E.9, installed and is operating plant to manufacture helically wound, continuous-fin tubing in lengths up to 18 ft. The product is, of course, used exclusively in the Company's extensive range of heaters for passenger cars and commercial vehicles.

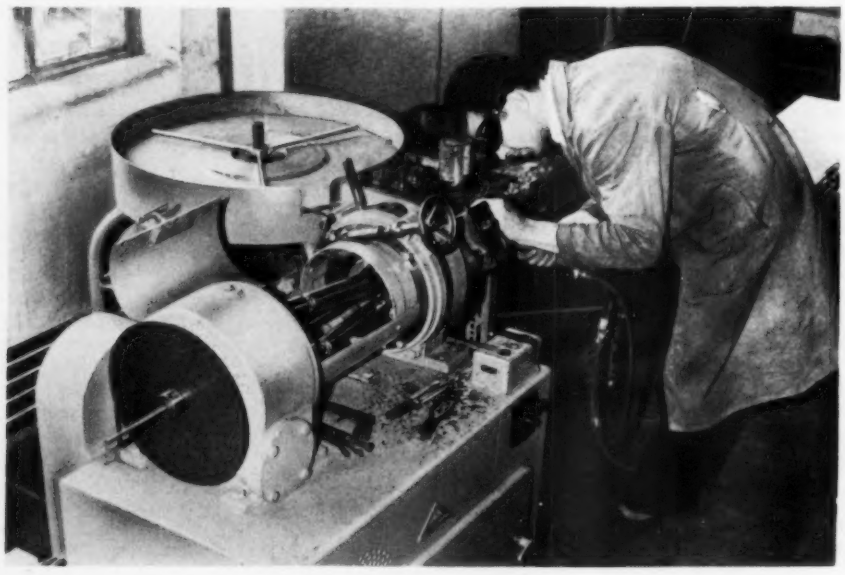
As stock material it can be supplied in straight lengths, with fins wound for specific distances and spaced from each other, to give a simple cut off leaving tube ends of suitable length for connections. Alternatively, tubes are supplied in cut lengths, in serpentine bends in one or two planes, and in single or multiple coils for heaters or exchangers of different patterns. Straight or curved cut lengths can be assembled in spaced end plates, with the protruding ends of pairs of adjacent tubes coupled by means of a 180 deg tubular bend, to restore continuity.

Finning machines

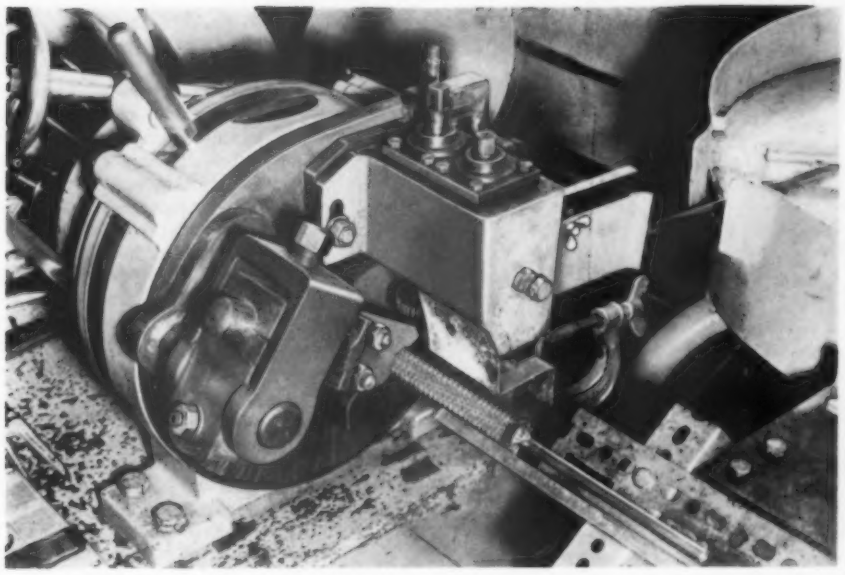
On the special machines employed for winding the strip fin on the tube, three types of finning can be produced, all from conventional, reeled, flat strip stock. The basic machine is standardized and special types of finning head are fitted to handle the different patterns. A line drawing shows the three varieties—straight, flanged and crimped. Each type of machine is made in two sizes, having core tube capacities of from 0·8 in to 4·0 in outside diameter and 0·4 in to 1·0 in outside diameter. That for producing the crimped fin—the most widely used pattern—is also built in a still smaller size having a tube capacity of from 0·24 in to 0·48 in outside diameter.

Fin height on the tube is determined by the tube diameter and the specific requirement in each case, and is limited by practical considerations in production and machine capacity. As regards capacity, fin height may be up to 2·0 in and 1·0 in on the larger and smaller machines respectively for straight and crimped patterns, and up to 1·2 in and 0·6 in for the flanged type. On the smallest crimped-fin machine, fins up to 0·48 in high can be wound.

In all the finning operations the strip material must be secured to the tube before winding is started, since the strip

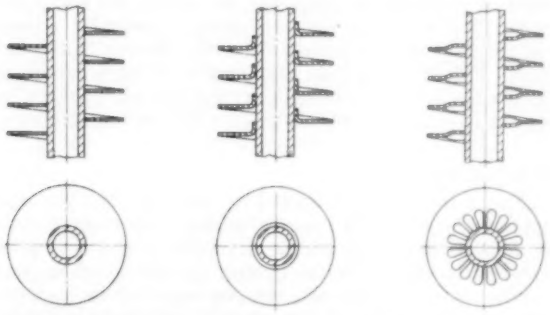


Welding the end of the fin strip to the core tube before winding is started. The termination of the winding must also be welded



Set up of tooling for production of crimped-fin tubing, showing strip feed, forming rolls, and the fin guide plates

is wound under tension. With crimped or straight finning it is essential also to secure the strip at the finish of the operation, or at any position where the finned tube is required to be cut. At Key-Leather, the practice is to secure the fin to the tube, using Sifbronze, so that end connections can subsequently be attached to the tube with a Johnson Matthey low-temperature brazing alloy, such as



Three types of continuously wound fin; straight, flanged, and crimped

C4 or Silfoss. Consequently, any risk of releasing the fin during the later operation is obviated.

With flanged finning, however, due to its greater rigidity, the termination welding operation is not necessary. Thus, continuous lengths of flanged-fin tubing can be produced and cut into lengths as required, thereby effecting a saving of time and material. Actually, production speeds are approximately 33 per cent faster than for straight or crimped fins. Other advantages of the flanged fin are improved rate of thermal transfer, due to the increased contact area between fin and tube and, as compared with crimped fin, somewhat easier cleaning or defrosting.

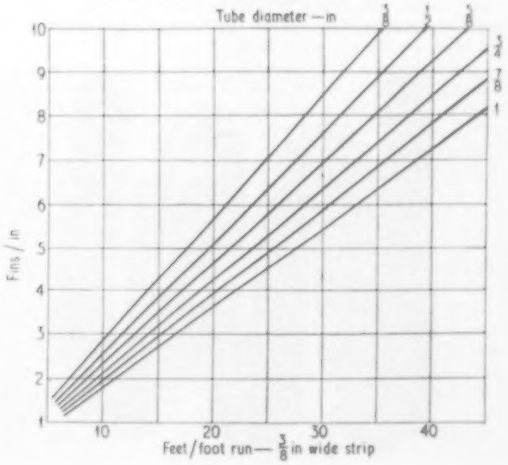
Tube and fin materials

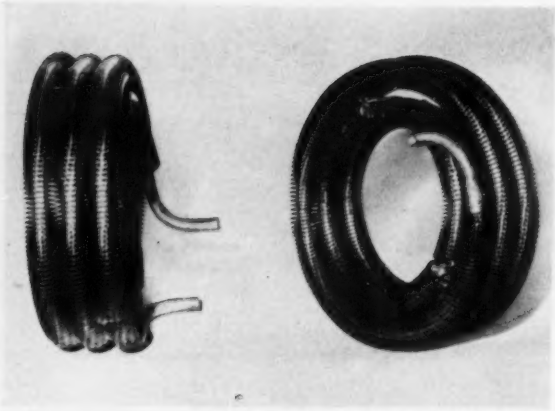
Virtually any metals can be used for tube and fin, and any combination of metals, in order to meet specific requirements. Steel, copper, brass, and aluminium tubes are all currently being produced. When steel tube is called for, the special Bundy tubing, now produced in Britain, is commonly used. This, it will be recalled, is a double-walled tube wrapped from a single strip that is copper-coated on the inside and tinned on the outside. Of course, solid drawn or seamed tubing is also used when specified. All-aluminium finned tubes are produced for aircraft applications. No special difficulty is encountered in the production of these tubes, but Argonarc inert gas-shielded welding equipment is required for securing the fin to the core tube. The thickness of fins may range from 0·006 in tinned copper to 20 S.W.G. tinned steel.

Machine construction

All machines are of generally similar construction and appearance, and are mounted on a fabricated box-type pedestal housing the driving motor and a steplessly variable cone belt gear. On the left of the machine is a large worm reduction gear from which a drive is taken through three universally jointed shafts to slightly serrated feed rollers in the finning head on the right of the machine. These shafts

Graph showing length of fin strip of specific width required per foot run of ranges of tube diameters and fin pitches





Multi-coil tube element for Key-Leather "Monsoon" two-fan heater

which are slidably splined, enable the feed rollers to be radially adjusted in relation to the machine axis to accommodate tubing of different diameters.

All elements of the drive are enclosed and run in an oil bath and a clutch is provided between the variable-speed gear and the machine driving mechanism. Power is furnished by a three-phase, pole-changing motor, thus making available alternate high-speed and low-speed ranges, each infinitely variable within limiting ratios.

Finning speeds on the smaller crimped-fin machine, for example, range from 58 to 324 r.p.m. and from 117 to 626 r.p.m. for tubing of 0·394 in diameter, and from 24 to 134 r.p.m. and 49 to 262 r.p.m. for 0·985 in diameter tubing. By using a steplessly variable gear, the drive can readily be adapted to suit different fin materials and a range of strip widths and thicknesses.

Production

The core tube is inserted from the left of the machine, through the worm-geared driving head and into the feed rollers located in the finning head. These rollers are then adjusted, by means of a single lever on the finning head, to engage the tube and to clamp it sufficiently tightly to impart a virtually positive drive. The lever is locked in its adjusted position by means of a screwthreaded grip. A handwheel immediately to the left of the lever is then operated to set the angle of the rollers relative to the machine axis and thus determine the rate of tube feed and, consequently, the pitch of the finning. This setting is infinitely variable between pitches of three and ten per inch of tube. Adjustment of pitch can be made while the machine is in operation as, for instance, where it is desired to wind to a closer pitch to provide additional support to the core tube in the region of a subsequent bend.

Strip stock for the fin is loaded on a ball-bearing reel stand positioned at the rear of the machine. The strip is run through guide rollers at the rear of the tool box in which the special crimping wheels are mounted. These wheels are selected from a range to suit the width of strip being handled, and their relationship is adjustable to regulate the depth of the corrugations formed in the strip. Opposite the tool box is arranged the holder for the two guide plates which support the crimped strip perpendicular to the tube.

When a new reel of fin strip is being loaded, the end of the strip is threaded through the guide rollers and fed by hand through the crimping wheels until it reaches the upper surface of the tube, to which it is welded. The outer guide plate is removed and, when the tube has been given a half-turn with the crimped strip lying against the inner plate, the outer plate is replaced over the strip and secured. Both the tool box and the guide plate holder are universally adjustable, enabling them to be readily set to position the fin perpendicular to the tube. The surface of the tube is roughened and scored by the feed rollers before the fin is wound. This serves a useful purpose in removing rust or scale from steel tube, ensuring a firm metal-to-metal contact between tube and fin, and improving conductivity.

Tube bending

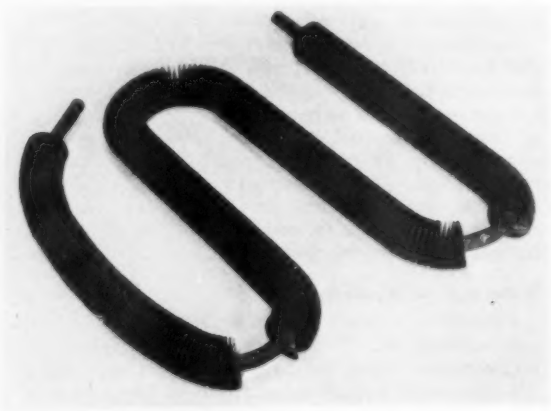
Typical serpentine and coiled elements for vehicle heaters are illustrated. Usually, the finned tubes are bent by hand over wooden formers or mandrels. Small bench-mounted bending machines are employed for setting the bare tube ends. The minimum practical radius of bend for a continuously finned tube is three times the diameter of the core tube. Reference has been made earlier to two methods of fabricating tubes to facilitate bending; by omitting fins in the bend area and by reducing the fin pitch in the area.

Test facilities

The Key-Leather Company is equipped to test and evaluate heat exchange apparatus for vehicle application. It can undertake the design, development and testing of air-conditioning equipment to meet specific operating conditions in any climate and also the manufacture of either component items or complete systems ready for installation.

Serpentine bend in two planes for special heat-exchange unit

Finned tube element of cab heater for municipal transport vehicles



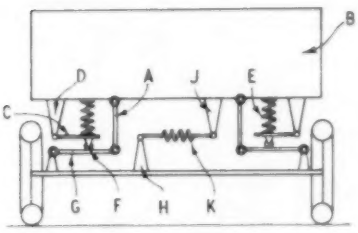
CURRENT PATENTS

SELECTED ABSTRACTS OF RECENTLY ISSUED SPECIFICATIONS

Reducing body roll on corners

SEVERAL methods are suggested not only of reducing the roll of a vehicle that is rounding a corner, but also of causing it to lean inwards if this is deemed necessary. In each of these methods, the slight outward movement of the body relative to the axles is made to operate a mechanism that increases the rate of the outer springs and decreases that of the inner ones. The simplest of the methods is illustrated.

One of the axles of a vehicle is connected to the body B by three linkages, two of which are at the ends of the axle, and are duplicates, and the other is approximately at the centre. In each of the end linkages, there is, just inboard of the wheel, a short vertical lug projecting from the top of the axle and, further inboard, a vertical swinging arm A suspended from the body B; a horizontal link G interconnects them. Above link G, and approximately parallel to it, is a radius arm C whose pivoted end is coupled to a lug projecting vertically downwards from the side of body B, and



No. 856497

attached to its free end is a roller F that runs on link G. Between body B and the free end of arm C is the road spring E for that side of the car.

Between these two linkages there is the third. A lug J projects downwards from the body, and a lug H upwards from the axle; between their ends is a horizontal coil spring K which is disposed approximately centrally between the wheels. When outward movement of the body relative to the axle occurs, its degree is determined by the rate of the spring K. As the roller F moves along link G it varies the effective rate of road spring E, so that the outer spring becomes stiffer, and the inner one softer.

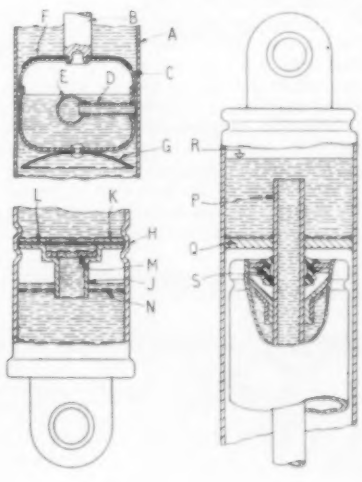
Provision is made in the specification for the springs E to be replaced by torsion bars pivoted at the fulcrum of arm C, and for the single transverse spring K to be replaced by two pre-stressed compression springs, one on each side of a central lug on the axle. Additionally, the variations of effective stiffness of the road spring can be controlled by a linkage connected to the steering mechanism of the vehicle, or by an auxiliary device such as a pendulum switch that is responsive to centrifugal force. In these cases, the springing arrangements are such that the body does not need to move transversely relative to the axle; instead, the springs themselves move along link G, and they can either move bodily or be pivoted at their upper ends. *Patent No.* 856497. *Daimler Benz (Germany).*

Telescopic dampers

A FEATURE of the design of telescopic dampers, as set forward in this specification, is that compensation is effected for the variations of the effective volume of the piston rod that arise during the normal working of the damper. This compensation is afforded by the presence of an air cavity within the structure of the damper, and various ways of incorporating such a cavity are put forward. Another claim is that the specified designs are simple, and suitable for mass production techniques.

In the upper left illustration, the compensating air space is shown contained within a hollow piston C. The piston comprises two cup shape pressings joined together. In one of these is a hole through which protrudes a shouldered portion of the piston rod B. Fixing is completed by the peening over of the rod. A small-bore tube D extends radially inwards from the wall of the piston to approximately its axis; through this tube, the fluid passes into and out of the piston. A perforated baffle E, to obviate frothing, is fitted at the inner end of the tube. Fixed, at their centres, immediately above and below the piston are two flat flexible plates F and G whose diameter is such that there is a very fine radial clearance between them

No. 856506



and the cylinder body A; these plates bend when subjected to the dynamic force of the damping fluid, and tend to adopt the shape of the ends of the piston. By suitably modifying the shape of the piston components, therefore, adjustments can be made in the flow rate of liquid past the piston. Tube D is positioned so that it is always under the surface of the fluid within the piston, and the volume of air present is such that it is adequate for all positions of the damper.

The lower left illustration is of a variant wherein the air space is at the lower end of the damper body. A flat sealing ring L is sandwiched between a fixing ring K and the flanged portion of a short tube J that is coaxial with the body. This sandwiched assembly is axially located by two circumferential, parallel, swaged grooves in the body, and thereby forms a partition, the space below which is the compensating air chamber. Sealing is assured by the pressure of ring L against the adjacent wall H. Tube J projects downwards, and fluid in the chamber is of such a volume that the lower end of the tube is always immersed. Around this end of the tube is a flat, perforated baffle, that extends outward to the body wall; and resting in a shouldered portion of the tube, just below the level of the sealing ring, there is a valve plate M in which are the orifices that determine the damping characteristics. This valve plate is restrained from excessive vertical movement by the presence of fixing ring K.

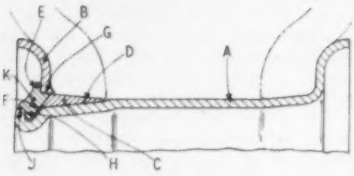
A third variant, with its air space at the top of the damper, is shown in the illustration at the right. The space is cylindrical, its upper wall being the flat plate to which the top mounting lug is fixed, and its lower wall a plate Q with a central hole in which the hollow piston rod P is welded. Fluid passes through a hole close to the piston into the hollow rod. Above this plate, the piston rod extends into the space to form a standpipe, and, below it, the tubular body extends to form a dust shroud for the body of the damper, at the top of which is seal S. During normal damper operation, the level R of fluid in the compensating space is always above the top of the standpipe. *Patent No.* 856506 *Firma Rheinmetall (Germany).*

Divided wheel rim

A WHEEL rim construction is proposed, which makes the fitting and removal of tyres for heavy vehicles quicker and simpler than with conventional rims. The configuration of the rim is such that either tubed or tubeless tyres can be accommodated, and provision is made for one of the two detachable rings, which are used to retain the tyre, to be made of rubber or a similar substance, according to the type of tyre to be used. The principal

component A of the rim has, at one side, an integral flanged portion for lateral location of the tyre bead, and, at the other, a tapered portion D that terminates at an annular groove.

A wedge section ring C is so shaped as to have one side mating with the taper surface D and another, at an acute angle to it, providing a surface to support the inner face of the tyre bead. This wedge ring serves to locate radially the retaining ring B that laterally supports the tyre bead. Axial location of both B and C is



No. 859178

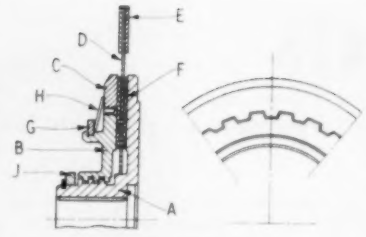
afforded by the split locking ring K; this ring has two concave sides, one of which bears against faces H and J in the rim A, and the other against faces E and G on ring B. Its face F bears against the third side of the wedge ring C.

Removal of locking ring K involves the prior movement of B inwards over a distance corresponding to the length of face G in ring K; the halves of ring K are then free to be lifted clear. Since retaining ring B is located radially on a tapered surface G, its resistance to inward movement is not as much as would be the case if the surface were cylindrical. Therefore, even after a long period of running, removal of a tyre is likely to be easier. Similarly, once the split ring K has been taken off, the removal of wedge section ring C is simple. It is this wedge ring C that can, if desired, be made of rubber, for applications where tubeless tyres are employed; alternatively, rubber sealing compound can be interposed between C and A. *Patent No.* 859178. *Jaroslav Hrdlicka* (*Czechoslovakia*).

Torque-limiting clutch disc

RAPID torque fluctuations in the transmission system of a car can set up high stresses in the components and can cause discomfort to the occupants of the car. Sudden changes from drive to overrun are particularly unpleasant, and this design is for a clutch disc assembly that transmits full drive torque but only a limited overrun torque. There are three main components: the disc D, and the two parts A and B that form the hub.

Both A and B are, in essence, cylinders each with a wide flange round one end. Around the periphery of the cylindrical part of A is very coarse square-section thread, and the bore is splined, in the manner of conventional clutch disc hubs. In the bore of B is a thread, to mate with that around A, so that angular motion of A relative to B will cause the flanged portions either to approach or to separate, and, in doing so, to grip or free the disc D



No. 859312

that is sandwiched between them. This disc has two sets of friction linings: one, at E, is acted upon by the clutch pressure plate, not shown in the illustration, while the other, at F, is interposed between the disc and the flanges of A and B. The disc is bored to a diameter such as to permit it to rotate about a plain portion of the periphery of A, when it is not restrained from doing so by the clamping action of the flanges.

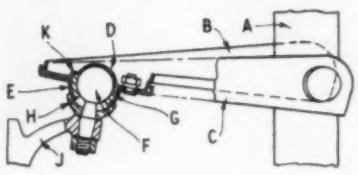
If the clutch normally rotates in a clockwise direction, as seen from the right of the illustration, a left-hand thread is necessary. To ensure that overrun conditions do not cause immediate freeing of the disc, a secondary clamping device is incorporated, in the form of a ring C that is acted upon by spring H. This ring is free to move axially relative to B, but not angularly, its restraint being afforded by the coarse spline system shown in the right hand illustration. When overrun conditions arise and the direction of torque is reversed, B moves towards its stop J, but ring C affords a degree of pressure against disc D, and eliminates any tendency to free-wheeling. Spring H can be a Belleville washer or any other type, acting against ring G. The limiting overrun torque is determined by the axial load imparted by the spring. *Patent No.* 859312. *Regie Nationale des Usines Renault* (*France*).

Wishbone construction

SIMPLICITY, lightness and low cost of production are the advantages claimed for this specification relating to a conventional wishbone type suspension system. A typical wishbone assembly is detailed: it comprises two pressings B and C, mounted on a common pivot pin on chassis member A. Each pressing forms one limb of a wishbone that has its apex at a ball joint which, in the case illustrated, is the top pivot of a wheel hub assembly J. At the apex, members B and C are bolted together, with the joint between them approximately horizontal.

The socket of the ball joint is formed by opposed part-spherical depressions, one in each member; the depression E in the

No. 850901

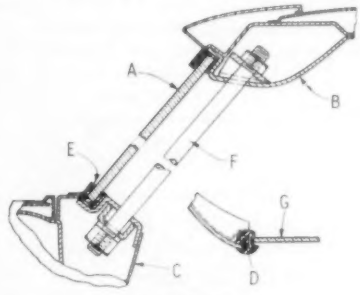


lower member C is of greater radius than that in B, so that a bearing cup G can be accommodated, and in it there is a hole that allows for insertion and angular movement of the ball stud F and cup G. Around the edge of depression D in member B there are several smaller depressions K. These register with lugs on cup G and prevent it rotating. There is provision for a shroud H to be fitted outside depression E, to exclude dust or mud.

Before the two members B and C are bolted together, a degree of movement of one relative to the other is possible about the ball stud axis, for the bolt holes are slightly elongated. This feature, it is claimed, obviates the need for precision in spacing apart the inboard pivot points, and thereby simplifies the manufacturing process. *Patent No.* 850901. *Ferdinand Porsche* (*Germany*).

Tie bars for windscreen apertures

AS is well known, efforts are constantly being made to reduce the size of the cross-section of windscreen pillars, to improve the range of vision of the drivers. Even so, they are still large enough to cause considerable interference, particularly on some cars with the wrap-round type of screen. The patent specification describes a method that affords a reduction of the pillar size by augmenting the structure with circular section tie bars tensioned between the top and bottom rails. Three

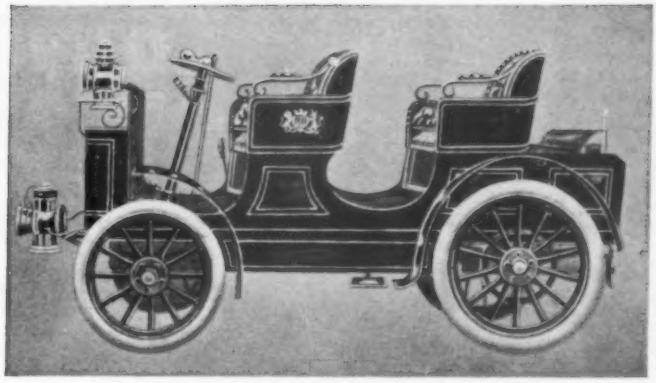


No. 858573

tie bars are specified, one on each side and the other at the centre. Since each tie bar is of small section, the obstruction offered by that at the centre is negligible.

The larger illustration is a sectional view through the centre of a windscreen A set in a channel section rubber surround E; B is a part of the roof structure and C is part of the scuttle. Tie bar F is set approximately parallel to the windscreen and it is tensioned by the two nuts that abut against brackets in B and C. One of the advantages claimed is that because of the tension, no sealing compound is required around the glass.

In the smaller illustration is a section through tie bar D at the end of a windscreen. This bar is shown set in the rubber sealer strip, but alternative arrangements are specified wherein the rubber only partly conceals the bar. The rubber section incorporates a lip, which contacts the glass of the car door and helps to form a seal against dust and draughts. *Patent No.* 858573. *Ford Motor Co.*



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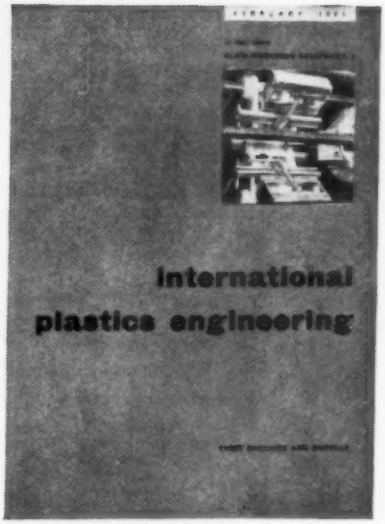

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To safeguard the structure of Leyland vehicles against heavy stress and the toughest going, Leyland Motors Ltd. specify Heli-Coil Screw Thread Inserts on the assembly line. The story behind Heli-Coil is both simple and convincing. Heli-Coil inserts, made in high tensile steel, make an easy, quick, permanent thread, far stronger than an unprotected one. The part is simply drilled and tapped and the Heli-Coil thread is inserted.

The cost per unit? . . . too small to estimate.
The strength? . . . quite astounding!

Heli-Coil Screw Thread Inserts can be an added strength on *your* behalf; better have all the details—send for sales leaflet APL.40/E5.

*HELI-COIL

SCREW THREAD INSERTS

**HELI-COIL is a registered trade mark.*

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THE BEARING FOR THE SIXTIES

Glacier Reticular Tin-Aluminium on Steel

Reticular tin-aluminium, as bonded to steel for high load-carrying capacity engine bearings, is an aluminium alloy, containing 20% tin and 1% copper, worked and heat-treated so that the tin is continuous only along grain edges, but not along grain faces, as is the case when this alloy is in the "as cast" condition. Working and heat-treatment enable the aluminium grains to bond into a continuous aluminium phase whilst the tin, although not distributed over the grain faces, is still a continuous network structure.

Micrograph of aluminium — 20% tin, as cast.

Micrograph of aluminium — 20% tin, rolled and annealed.

The latest development in Plain Bearings, defined above in technical terms, offers manufacturers and private motorists—

New standard of load-carrying capacity.
Exceptional life.
Compatibility with conventional crankshaft materials.
Resistance to corrosion attacks.

It has now been adopted by—
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Our licencees, TRIONE of Turin, supply FIAT and S.A.M.E. (Fratelli Cassani).

RETICULAR TIN-ALUMINIUM bearings are an exclusive product of the Glacier Metal Company Ltd., and are also marketed by their licencees.

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THE GLACIER METAL COMPANY LTD · ALPERTON · WEMBLEY · MIDDLESEX.

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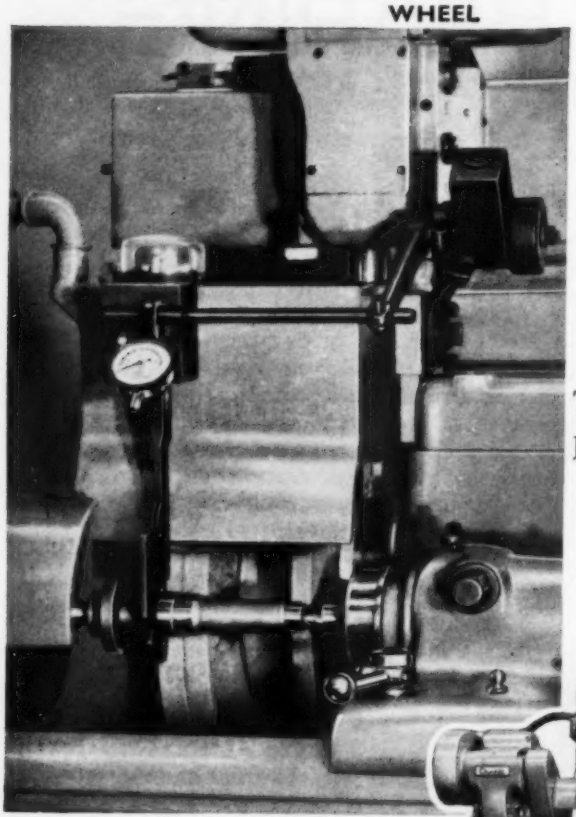

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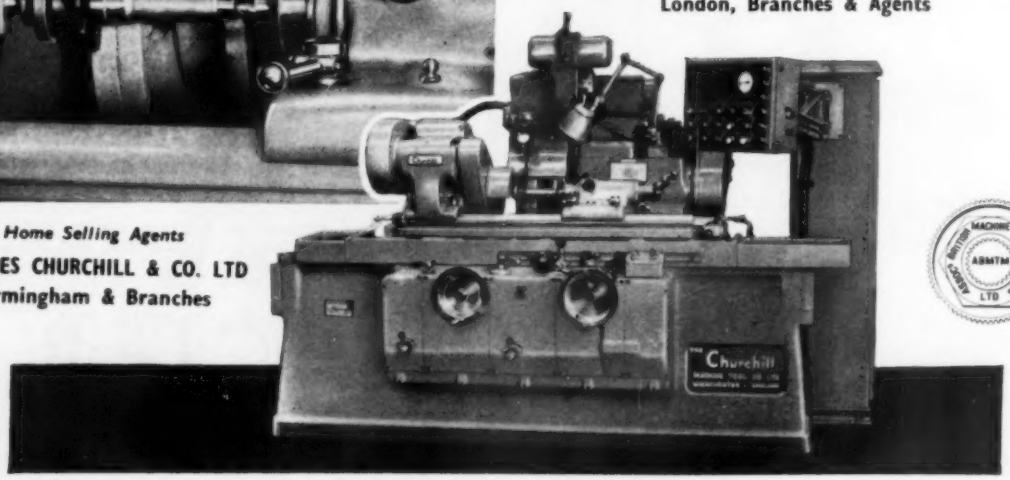

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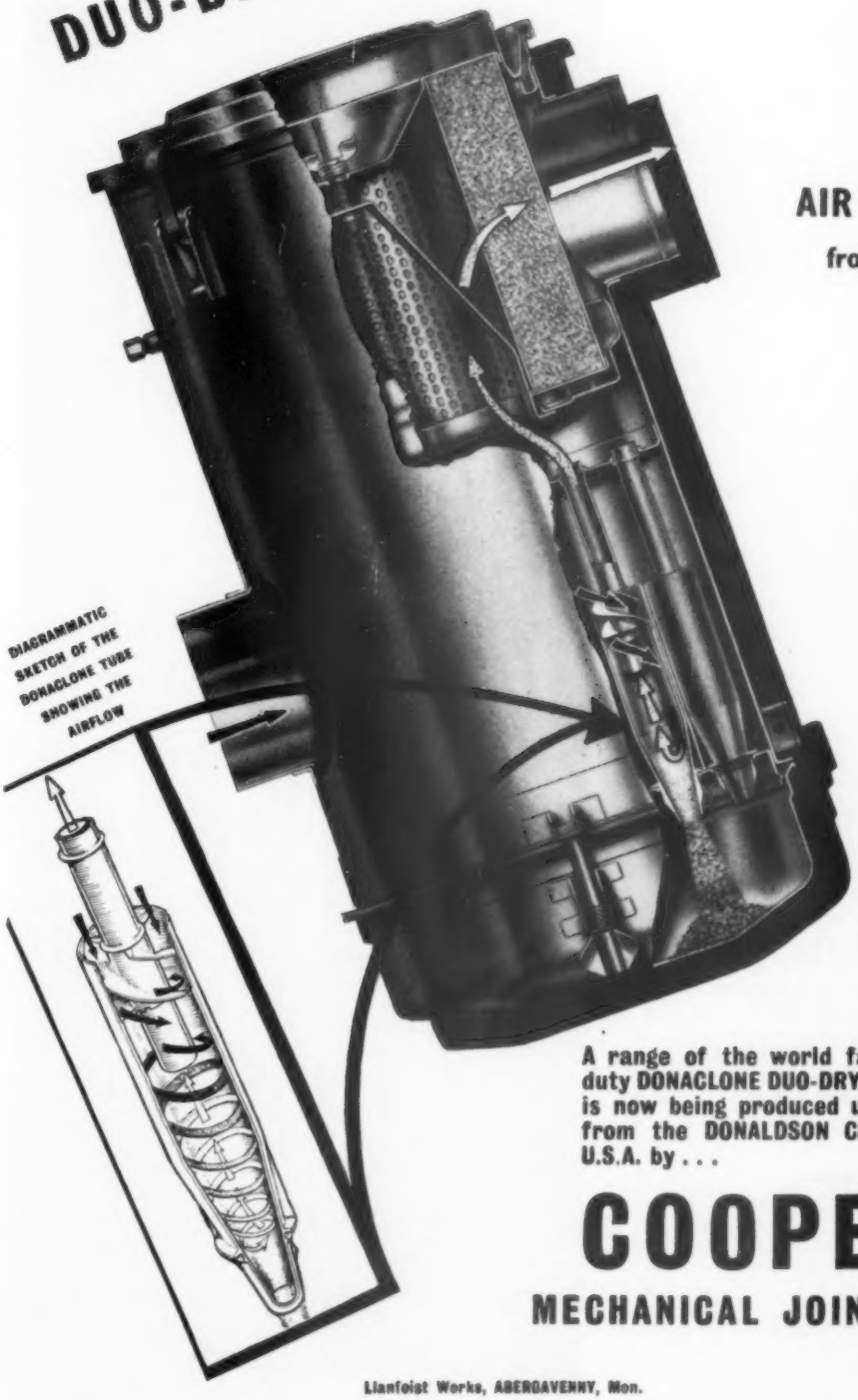

DIAGRAMMATIC SKETCH OF THE DONACLONE TUBE SHOWING THE AIRFLOW

AIR FLOW CAPACITIES
from 450 to 950 c.f.m.

Up to 98% of foreign particles are removed by the primary centifruge stage, with the Long Life paper element bringing the overall efficiency up to 99.9% as tested to B.S.S. 1701

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A range of the world famous heavy duty DONACLONE DUO-DRY Air Cleaners is now being produced under license from the DONALDSON Company Inc., U.S.A. by . . .

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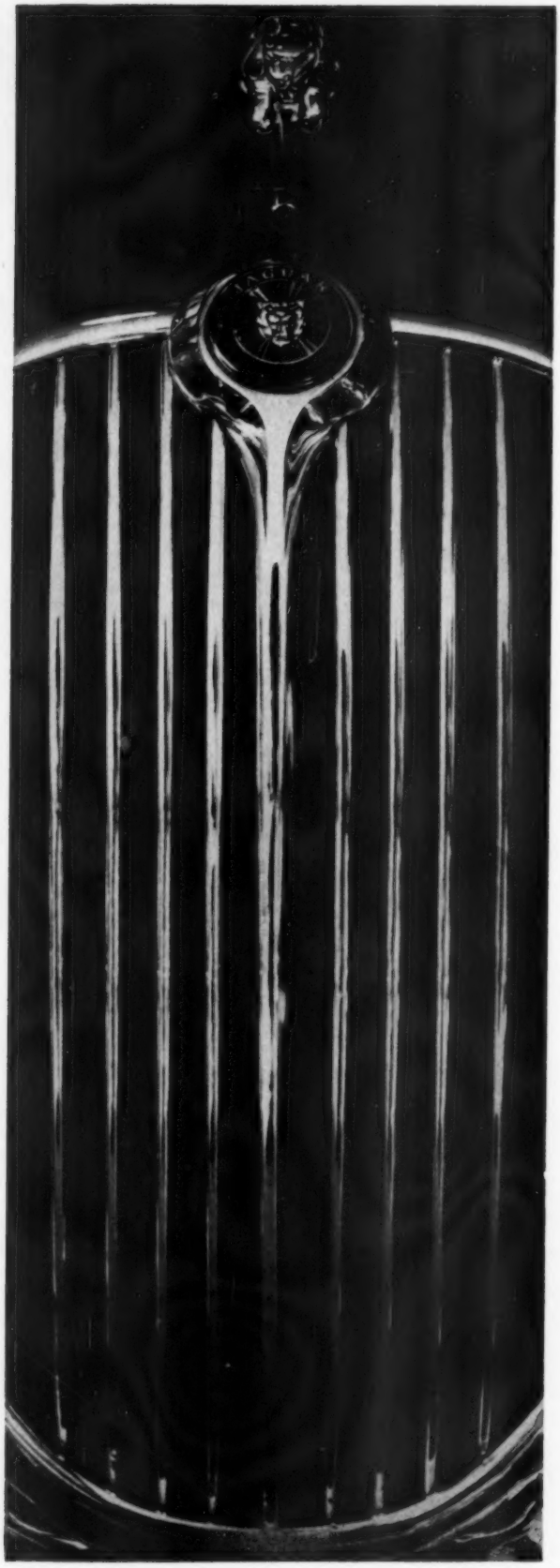

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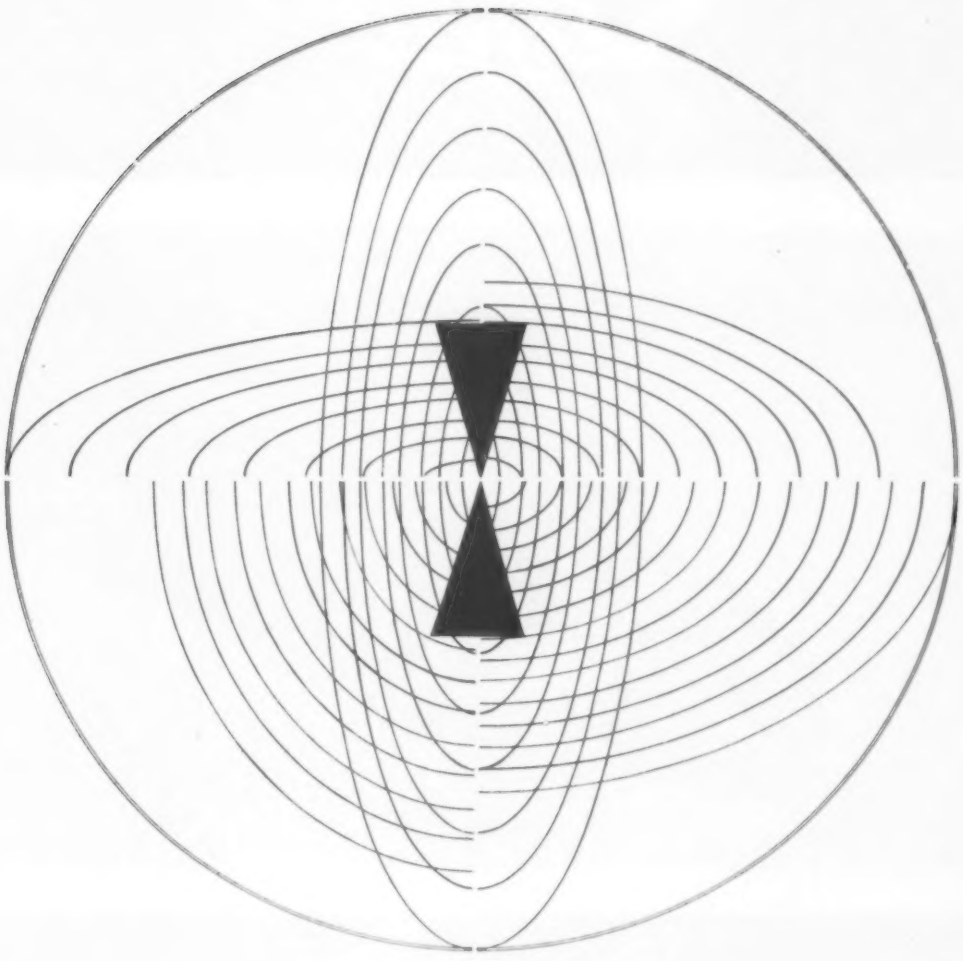

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In the last 12 months, among other articles, we have supplied more than 60 million Piston Rings to the European Manufacturers of engines, jets, and gears.

At present more than 3,700 men are employed in our works.

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Simms

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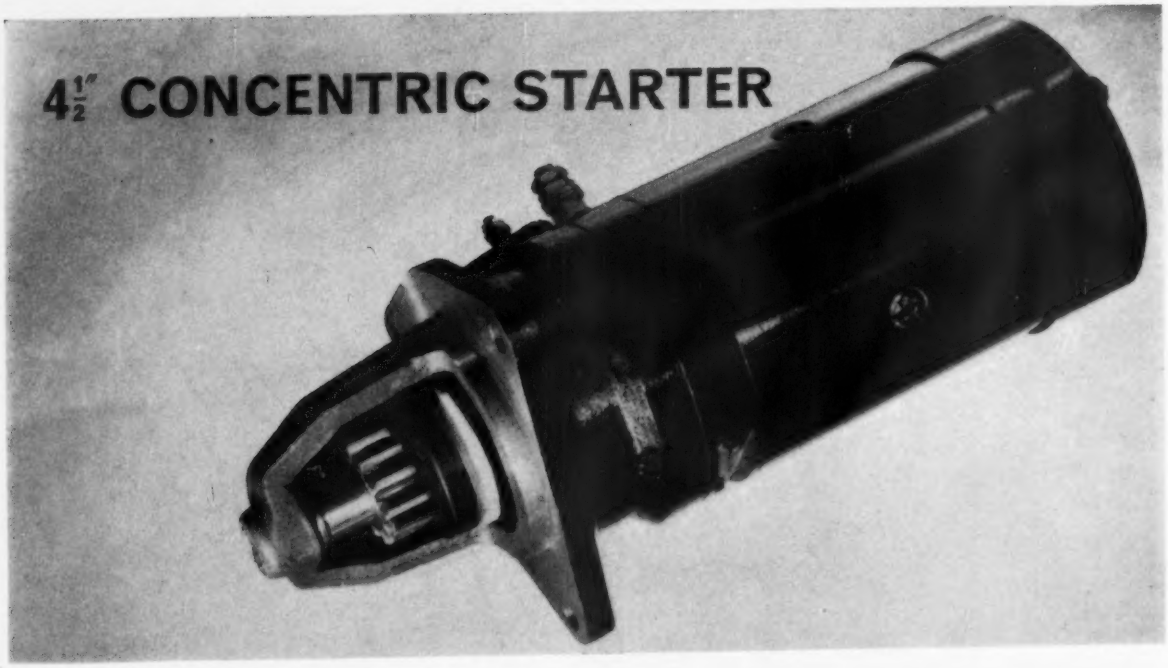
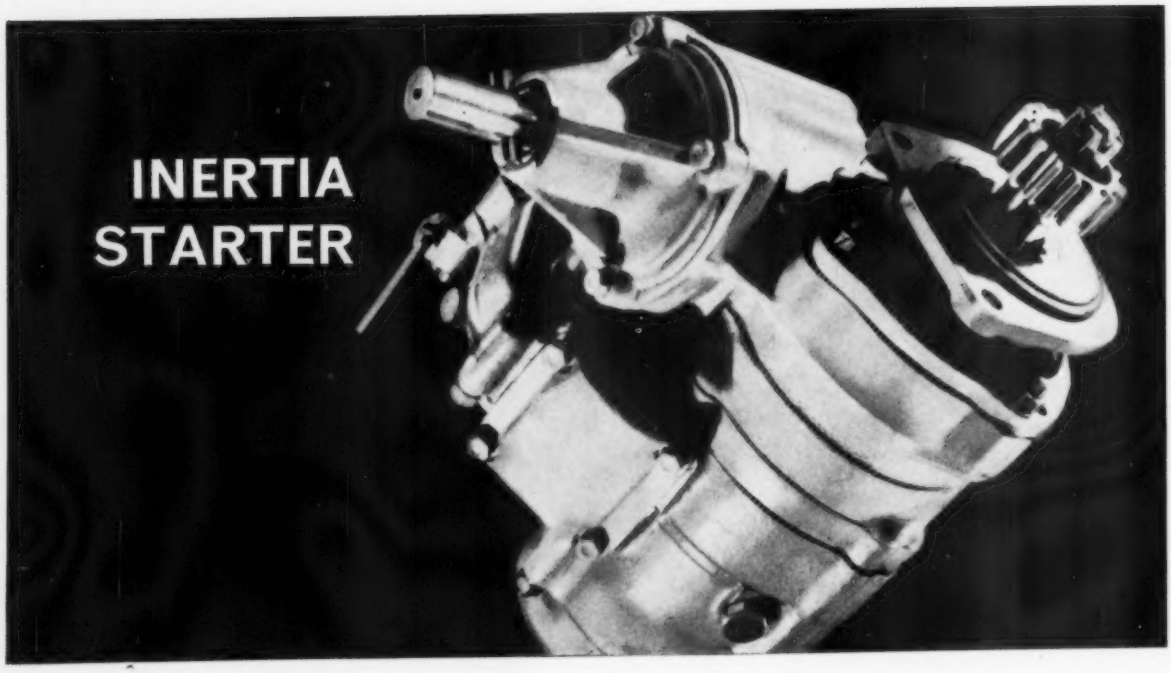
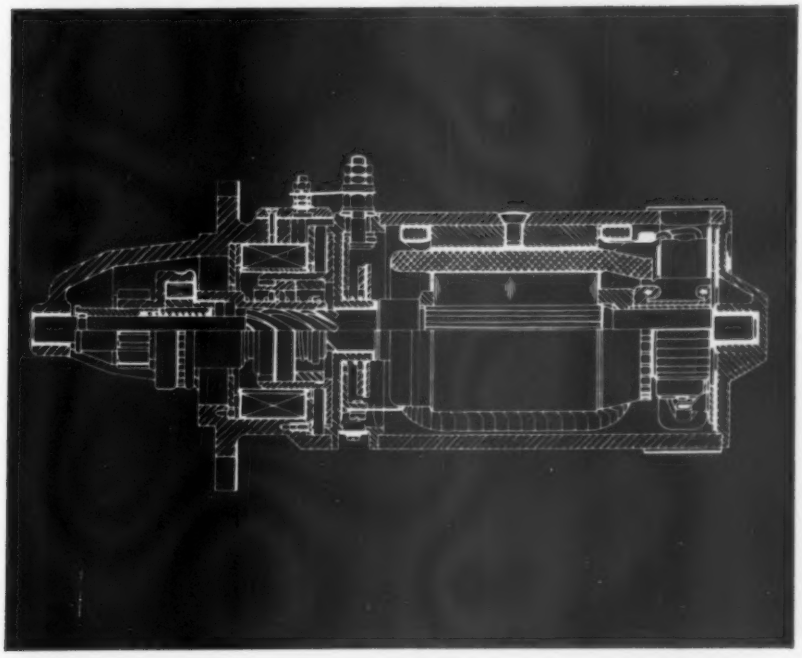


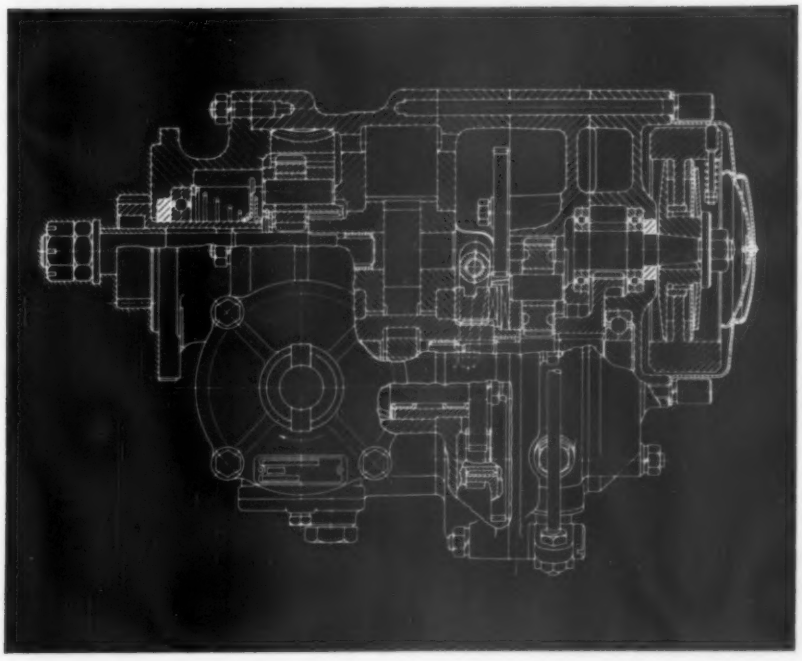
INERTIA STARTER



Simms



Does the work formerly done by a 5" starter; combines robustness with compactness. The cylindrical construction without projections, together with the flange mounting, makes for simple installation and easy withdrawal. The pinion is positively engaged by magnetic action instead of by inertia. The starter has a free-wheel pinion drive and built-in magnetic lock, and can be supplied either insulated or earth return for 12 and 24 volt systems.



This is a sure-fire starter for diesels, where batteries are unreliable or inadmissible. In the tropics, for example, where, besides high temperatures, maintenance is often sketchy; on contractors and civil-engineering plant, which has to stand up to rough usage and some neglect; and where there is a fire risk, as in mines and refineries. Its high starting efficiency is due to a method of coupling the flywheel to the pinion which does not rely on friction clutches with their high energy losses.

SIMMS MOTOR UNITS LIMITED

EAST FINCHLEY · LONDON · N.2

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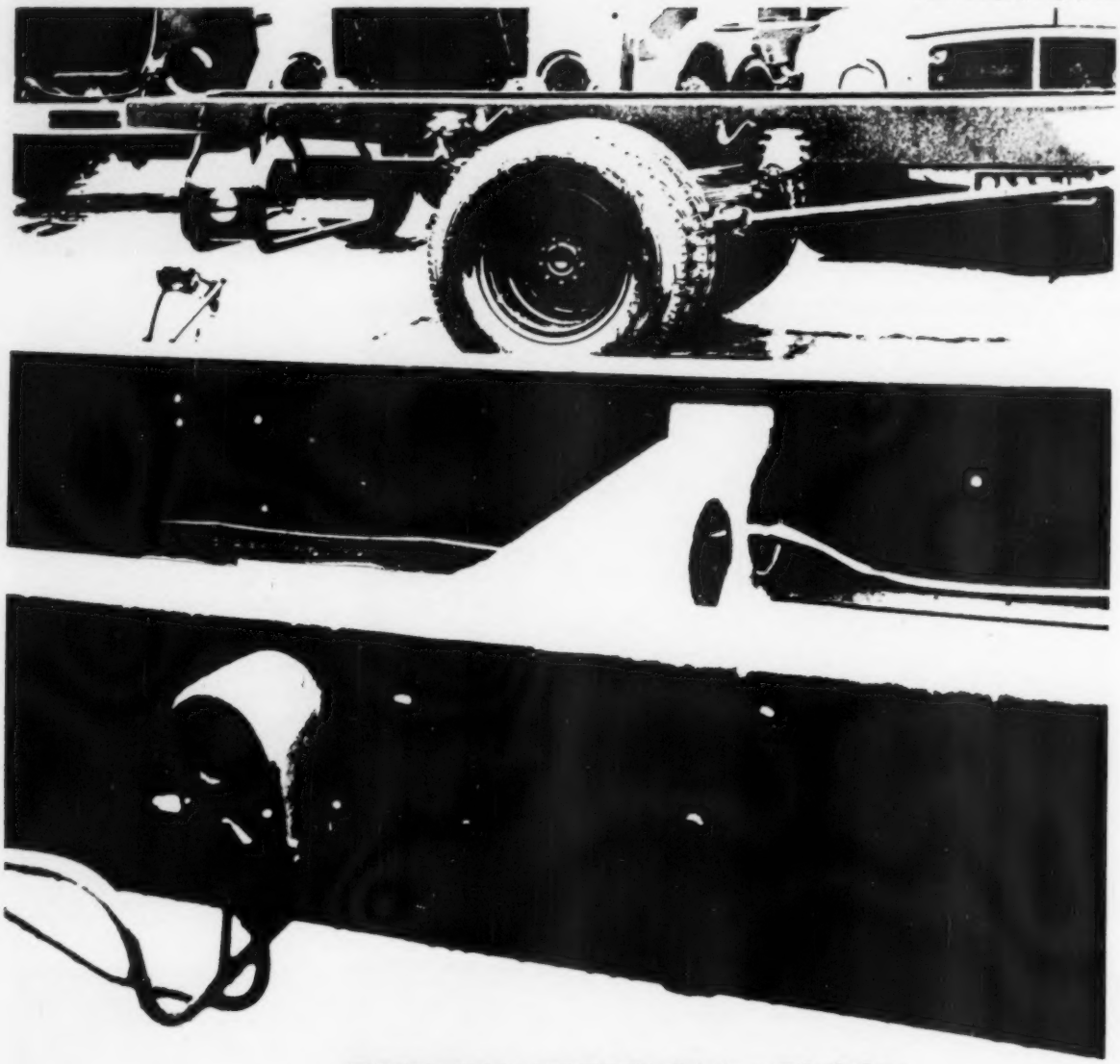

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more than meets the eye

At the core of most heavier vehicles is a Rubery Owen frame,
They look simple enough to make, and superficially
seem little changed with the years.
In fact costs have been revolutionised by forcing up the
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by finding better steels and in cheaper forms—by assembly
in distortion-compensating powered jigs . . .
At every stage the first moves have been made by RO

MOTOR RO DIVISION *Manufacturers of vital components*

Member of the Owen Organisation

3

PRECISION . . .

wm 70 Junior

7" Centre Lathe

2 h.p. motor, 8 speeds, 30-437 r.p.m.
Also alternatives:
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Sizes made to admit 45", 54", and 72" between centres.

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The machines selected for this specialised training include a number of 70 JUNIOR LATHES, which combine accuracy and productivity—characteristics which make them worthy of a place in the best workshops.

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WM 30

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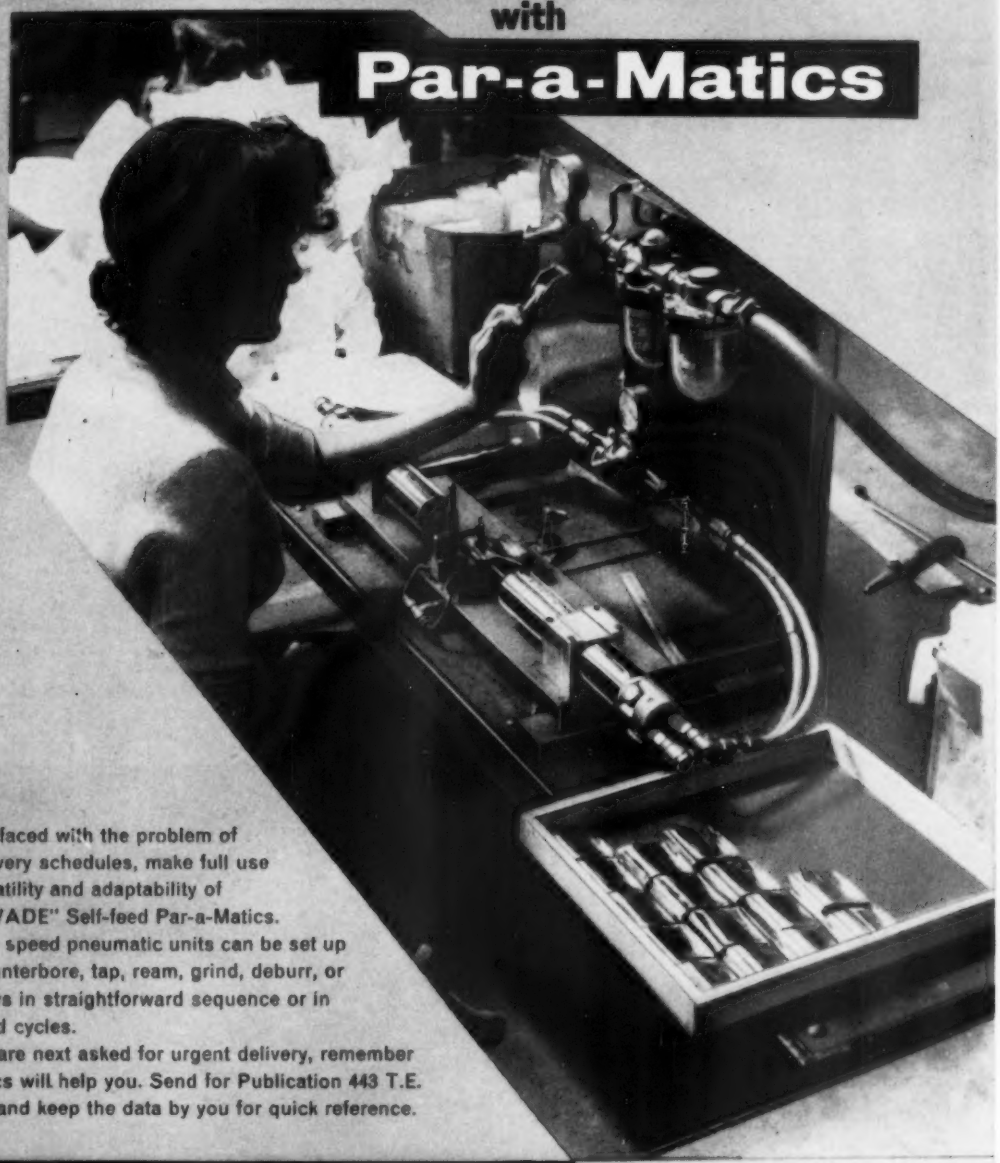
with

Par-a-Matics



Engineers, faced with the problem of urgent delivery schedules, make full use of the versatility and adaptability of "BROOMWADE" Self-feed Par-a-Matics. These high speed pneumatic units can be set up to drill, counterbore, tap, ream, grind, deburr, or drive screws in straightforward sequence or in complicated cycles.

When you are next asked for urgent delivery, remember Par-a-Matics will help you. Send for Publication 443 T.E. right away and keep the data by you for quick reference.

A "BROOMWADE" Par-a-Matic set-up in operation at Messrs. A. W. Chapman Ltd., manufacturers of the well-known "Leveroll" seating equipment, drilling car safety belt buckles at a production rate of approximately 700 to 1000 per hour.

Photograph by courtesy of Messrs. A. W. Chapman Ltd.

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The first law of engine economics!

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Oil Pumps, Water Pumps,
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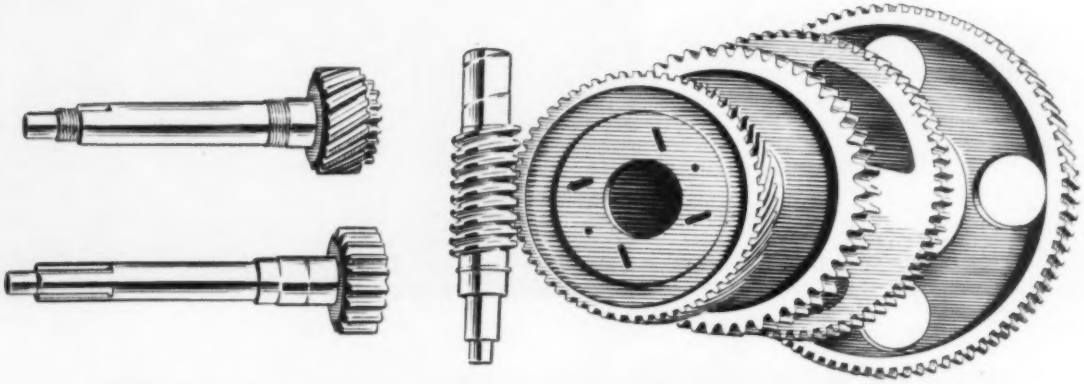

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Tipton Staffs.
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Those people born under the sign of the Kite ascend in ever increasing circles until they reach the top of their profession. Kite men become chief purchasing officers, chief engineers, chief draughtsmen and chief designers. Kite men are perfectionists with eyes like hawks. They hunt for a material that combines the properties of many materials—a material that is light yet strong and hardwearing, resistant to corrosion and a good electrical insulator. They also expect this ideal material to resist deterioration in storage, to machine easily with ordinary tools, and to be available in sheets, tubes, rods, angles, and channels. Many Kite men have already spotted this ideal material—"KITE" brand Tufnol. They have also discovered that Tufnol is available in eleven other brands, each with pre-determined properties.
All brands of Tufnol are laminated plastics; each formulated to satisfy specific requirements. If your birthday falls between January 1st and December 31st, this could be your lucky week—the week you discovered Tufnol.
'Phone or write to your local Tufnol Branch Office and we predict you'll thank your lucky stars.

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P2

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for all your sheet metal curving or cylinder work

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The Besco Production All-Steel Bending Rollers will form all curves, parallel or tapered cylinder work in sheet metal of all kinds. A patented device for freeing the roller carrying a complete cylinder allows the cylinder to be removed easily, giving a fine undistorted result. The frames of all machines are of pressed steel sections welded together, giving a tough rigid frame of virtually unbreakable character.

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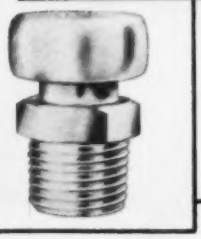
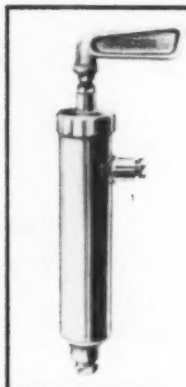
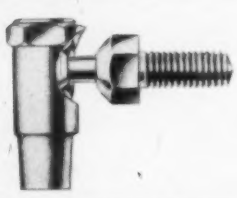
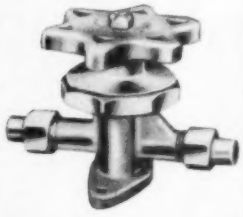


Among the one thousand and one small parts made by Benton and Stone Ltd., and all designed to make engines and industry operate smoothly, there are many Enots fittings and accessories ideally suited to automobiles and marine use, such as those illustrated here. May we send you our illustrated lists? Illustrations left to right :— Breather, Side-lever Grease Gun, Throttle Control Ball Joint, Fuel, Oil or Water quick-action Filler Cap, Screw-down packless Fuel Cock, Engine Sump Pump.







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Vertical or horizontal, streamlined or functional

THE INCREDIBLY VERSATILE VERSO

This new Holroyd 2¼" centres motorised worm gear speed reducer has been designed to meet the need for a self-contained drive suitable for continuous use, and one which will look right in any surroundings. No matter what the application, it is possible to select from its variety of assemblies and mounting positions, an arrangement which makes it appear an integral part of the surrounding machinery, and *not* an added afterthought.
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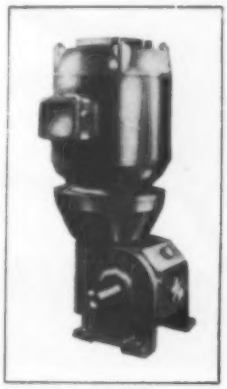
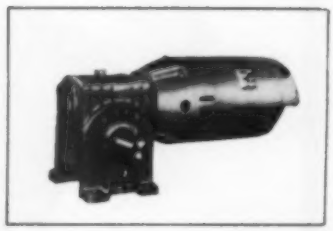
Please write for catalogue V.60 which gives further technical information.





Holroyd

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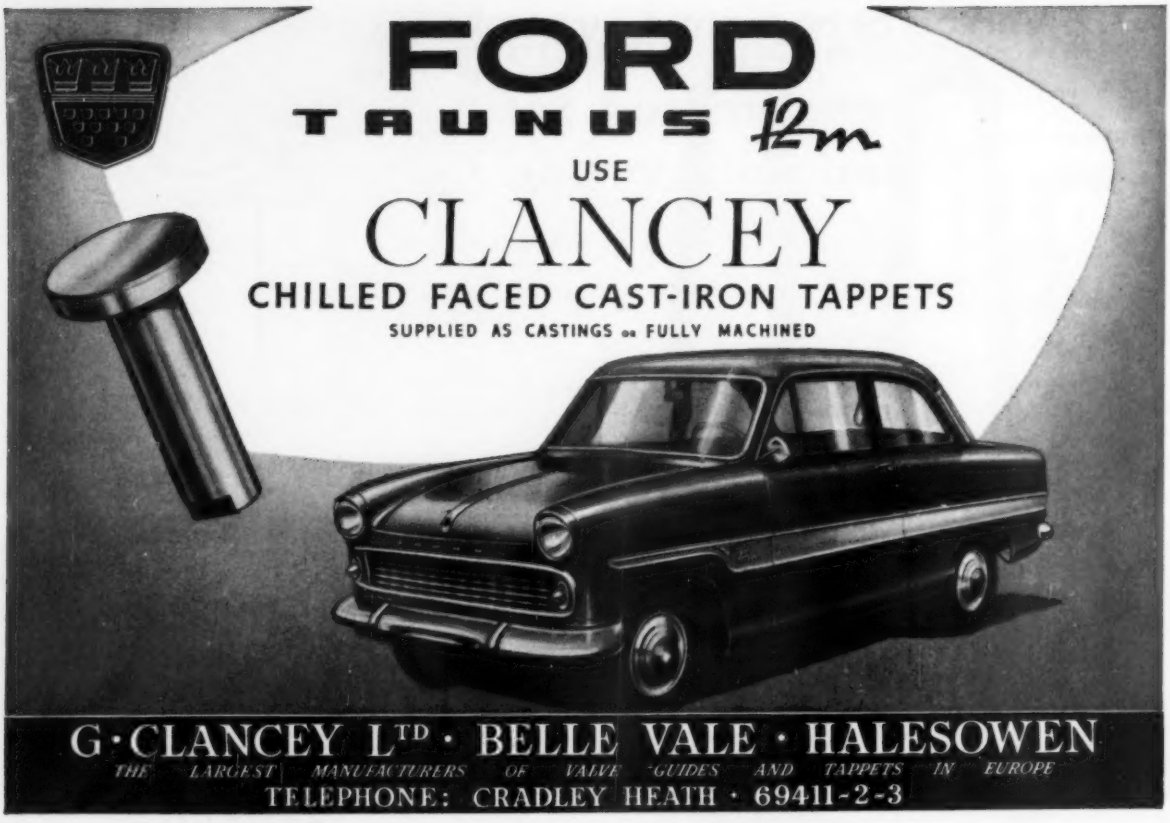
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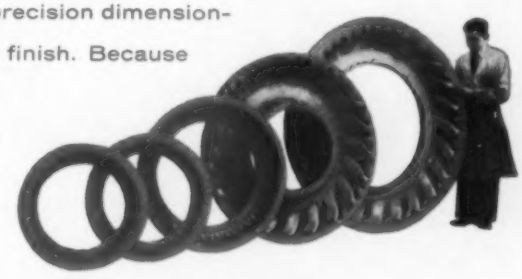
To deal with constantly increasing demands, this new extension to the William Mills Works at Wednesbury has been built specifically for the production of light alloy castings by plaster moulding. Castings produced by this method are of high precision dimensionally and have an excellent surface finish. Because of the quality and accuracy of the castings, tyre moulds of the types illustrated are produced by the plaster moulding system.



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The Life of a Specialloid PISTON

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750,000 miles

was the distance travelled by a bus operated by Compania Peruana de Omnibus S.A.— *without it being found necessary to dismount the engine for repair*

The original set of Specialloid pistons was used throughout the entire distance

— more than three times the distance to the moon!

COMPANIA PERUANA DE OMNIBUS S.A.

OFICINA: PARQUE UNIVERSITARIO 1308 TELEFONO 39681 — APARTADO 3190 LIMA—PERU — TALLERES: AV. PROLONGACIAON CANGLLO 530 TELEFONO 36040

Herewith we wish to certify that Omnibus No. 2., of "SCANIA VABIS" make, Motor No. 62 1 79, Chassis No. 91 9 70, which operates on the Lima-Ica Line, has run 1,200,000 kilometres without it being found necessary to dismount the engine for repair.

Lima, 9th April, 1957

PERUVIAN OMNIBUS COMPANY LIMITED
J. BLUME T.
Principal of the Transport Department

The undersigned, PUBLIC NOTARY AND COMMISSIONER FOR OATHS, CERTIFIES that Mr. JUAN BLUME TRAVERSO, proving his identity with his electoral papers number six hundred fourteen thousand five hundred and ninety four and his military papers number eight hundred and seventy seven thousand six hundred and sixty two, was present in the offices of the aforesaid Public Notary, with the object of having legalised his signature in the DECLARATION which he has signed as Technical Principal of the Transport Department of the Peruvian Omnibus Company Limited, ratifying before me the said declaration which he now repeats and says as follows: "Herewith we wish to certify that Omnibus number two, of "SCANIA VABIS" make, Motor number sixty two thousand one hundred and seventy nine, Chassis number ninety one thousand nine hundred and seventy, which operates on the Lima-Ica Line, has run one million and two hundred thousand kilometres without it being found necessary to dismount the engine for repair", which he signs again in my presence, in Lima, on the thirteenth day of the month of April of the year one thousand nine hundred and fifty seven.

J. BLUME T.

DR. DANIEL CESPEDES
NOTARIO PUBLICO Y DE HACIENDA

This is a translation of an affidavit drawn up by Dr. Daniel Cespedes, Notario Publico y de Hacienda.

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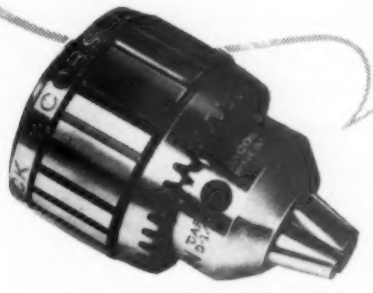

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"Your dealer can supply genuine Jacobs chucks in all sizes for light, medium or heavy duty"

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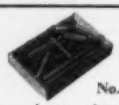

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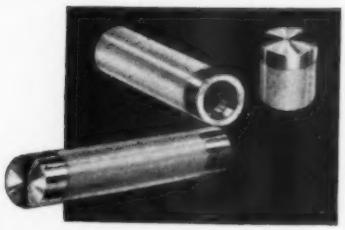

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" . . . exceptional mileages
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. . . fallen considerably"

writes Mr. H. W. Howe, Transport Manager, Monkton Motors Ltd., Uxbridge

24th October, 1960.

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W. H. Howe,
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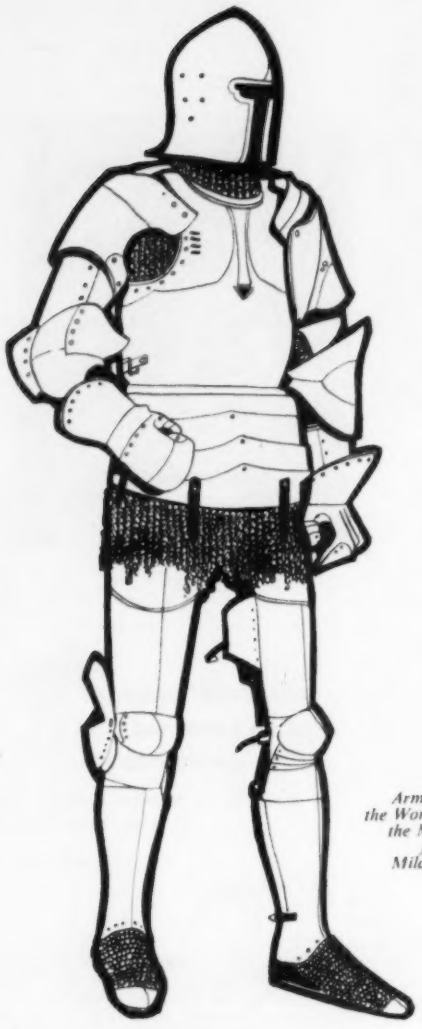

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A true appreciation of the value of armour and the consummate skill of its making was displayed in the superb products of the 15th century armourers. Although mail was still widely used, it latterly became a supplement of steel plate, which at this stage remained mainly undecorated but was outstanding for the sculptured perfection of its formation to the needs and outline of wearer. The existence of fine examples in modern collections is tribute enough to the workmanship of this period.

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Maximum diameter of hole	9 1/16″
Maximum movement of longitudinal slide	23½″
Maximum depth of hole	12⅜″

KAMENICEK MODEL BUA.20 UNIVERSAL GRINDER

Hydraulically controlled fully automatic cycle.

Swing over table	7⅞″
Distance between centres	17⅝″
Table feeds infinitely variable ...	2″/177″ per min.

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Working surface of table approx. ...	71″ × 25″
Power longitudinal movement approx.	71″
Power cross movement	29½″
Milling spindle motor...	25 h.p.
All feeds infinitely variable	

SKODA MODEL WD.160 RAM TYPE HORIZONTAL BORING, DRILLING & MILLING MACHINE

Diameter of spindle	6 5/16″
Dimensions of quadrilateral ram ...	17 1/16″ × 17 1/16″
Maximum travel of ram	49″
Vertical travel of headstock on column	98″
Travel of column on bed	124″

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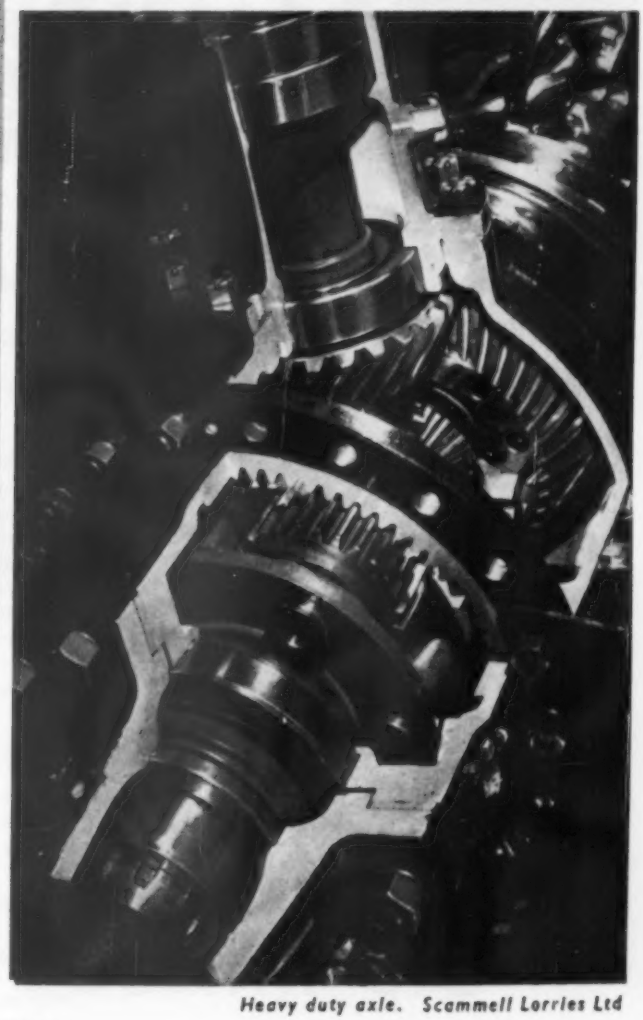

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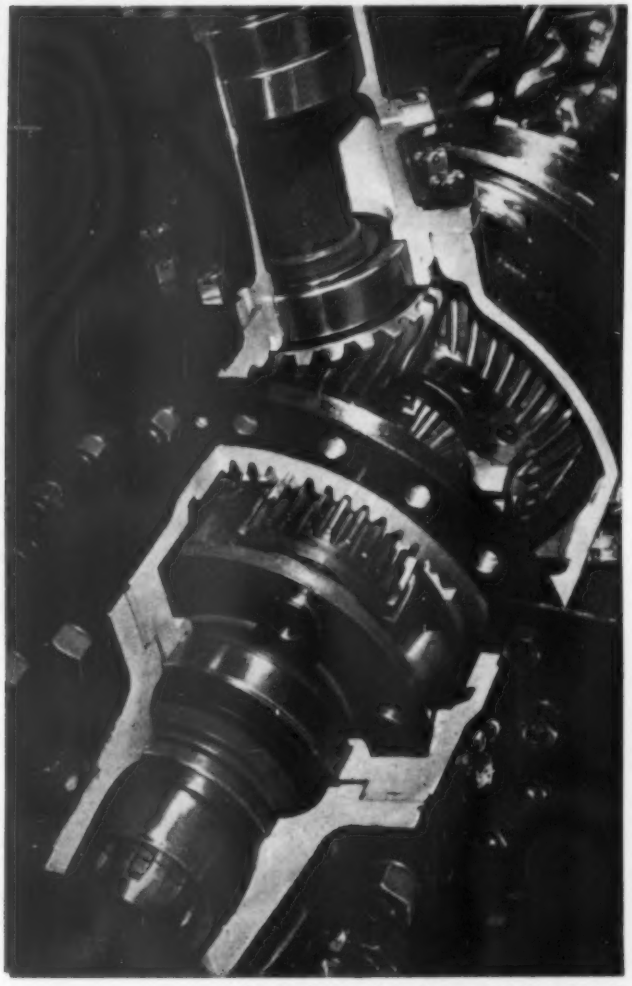

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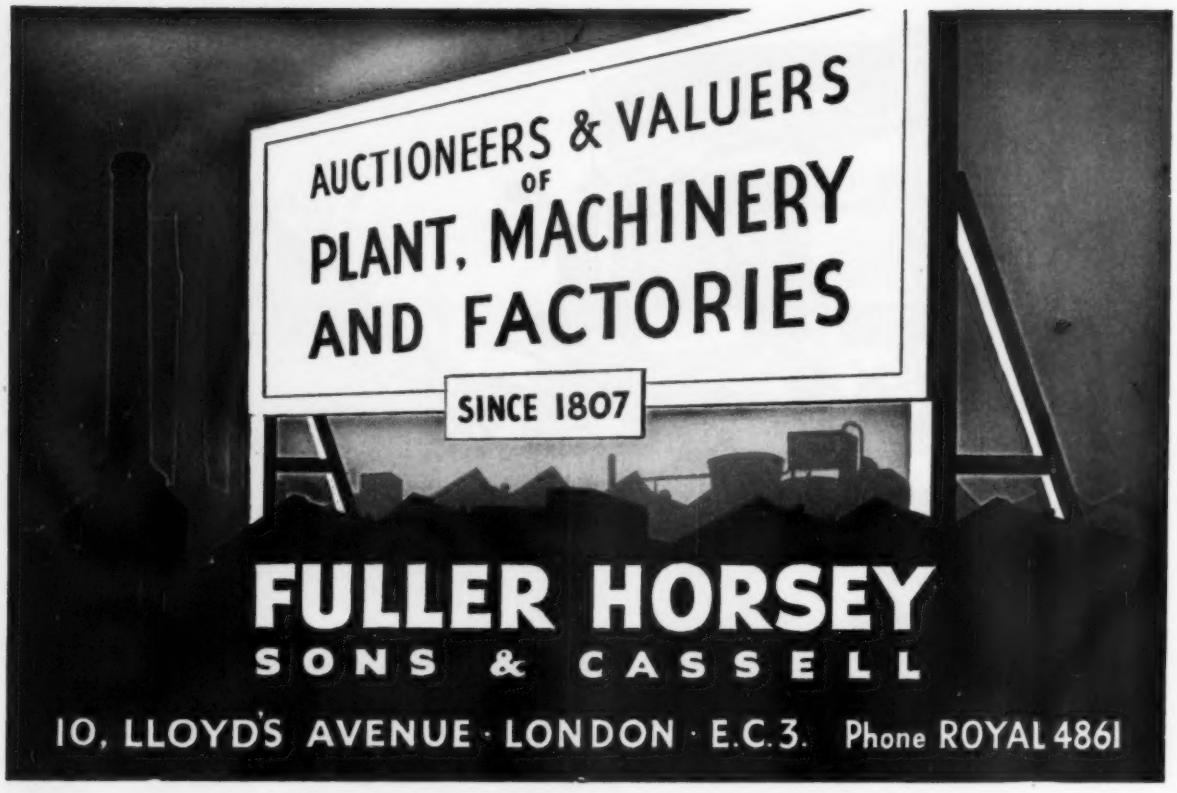

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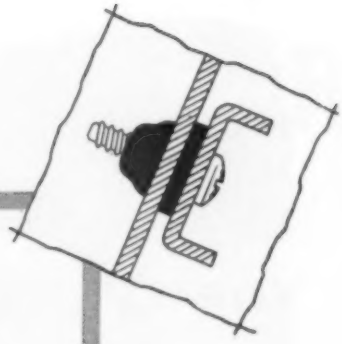

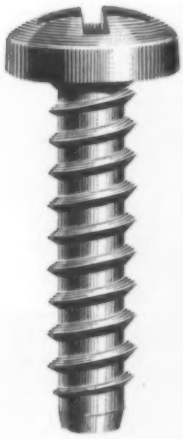

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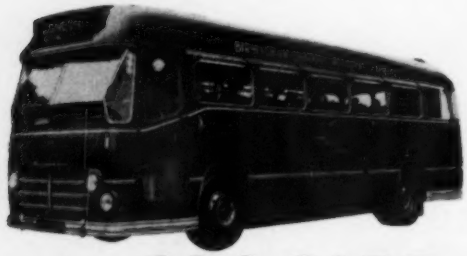

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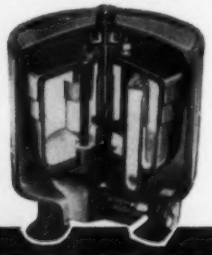

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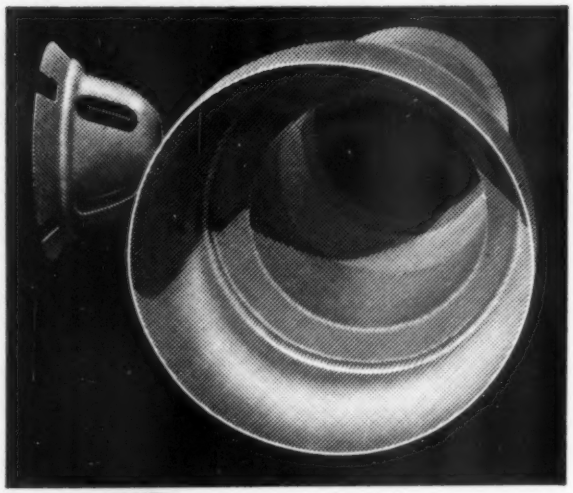

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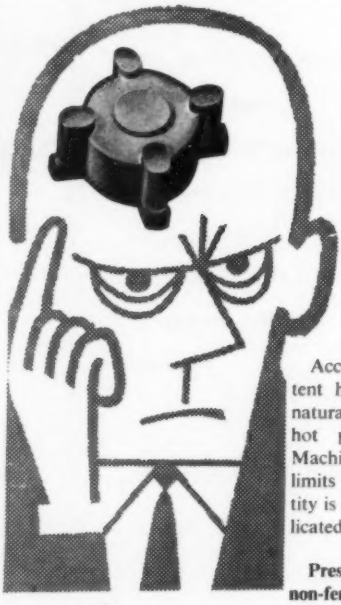

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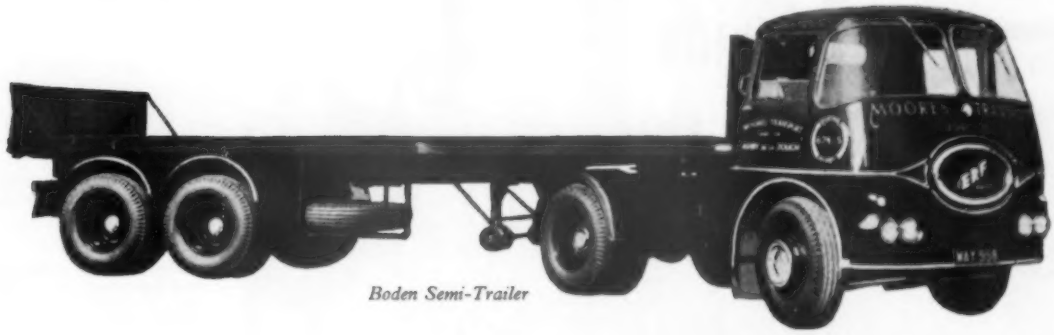

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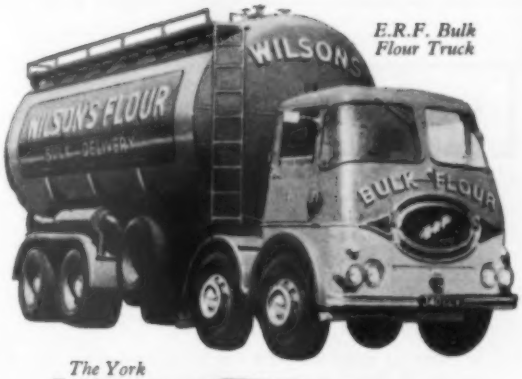

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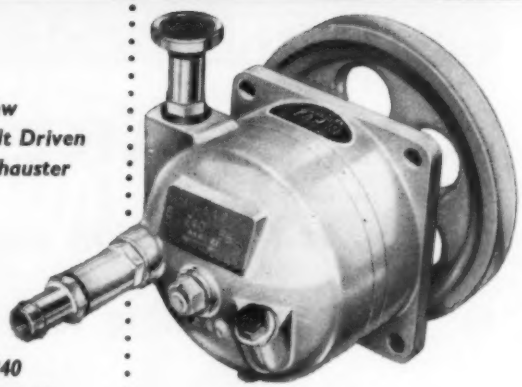

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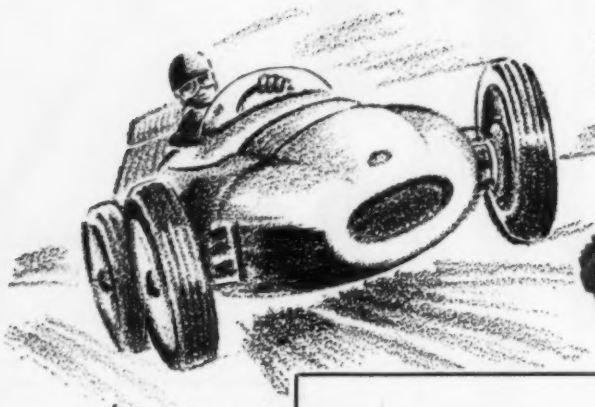

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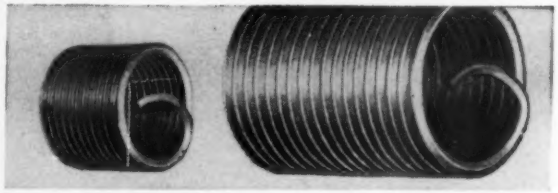

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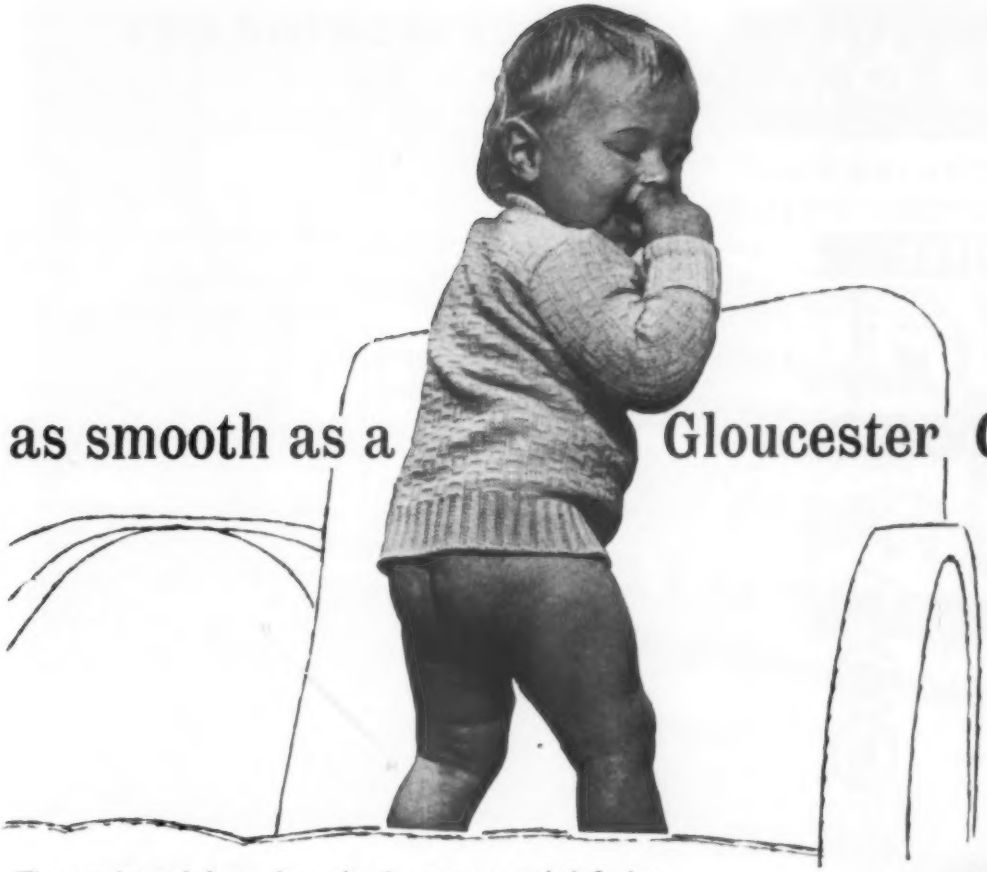

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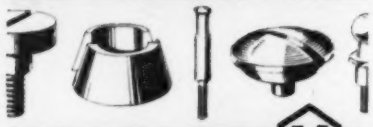

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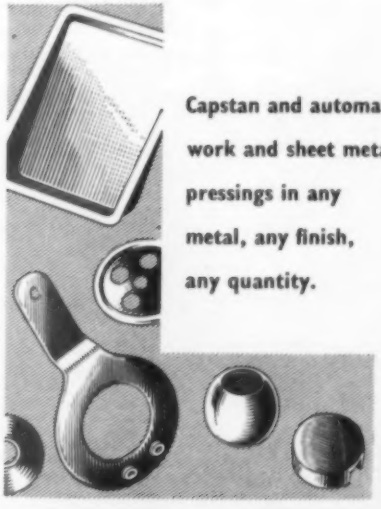

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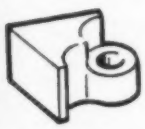

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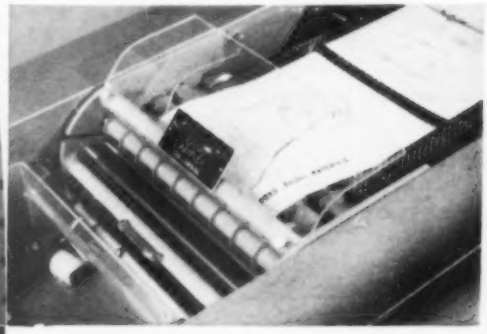

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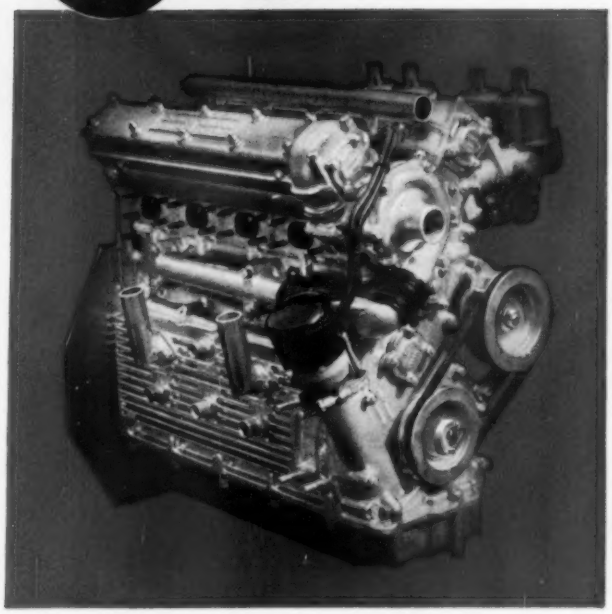

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